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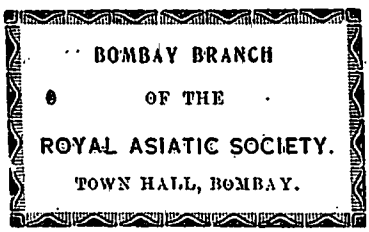

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REPORT

ON

METALLURGICAL AND ENGINEERING INDUSTRIES

(RECENT DEVELOPMENTS)

BY
DR. P. J. THOMAS

JAIN BOOK AGENCY
GOVT. BOOK-SELLERS,
CONNAUGHT PLACE
NEW DELHI.

Price Rs. 1/6/- or 2sh.

Printed at the Delhi Printing Works, Delhi.

This report was prepared by Dr. P. J. Thomas who was appointed as Officer on Special Duty in the late Supply Department to carry out an investigation into the industries which had been started or were developed to meet the requirements of the Defence Services, in connection with the War. Although the report was produced at the instance of the Government of India, the facts and figures given and the opinions expressed in the report should not be regarded as official.

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INTRODUCTION

For the effective prosecution of modern war, guns, bombs, armoured vehicles, ships, aircraft, etc., are essential and therefore countries where the metallurgical, engineering, and chemical industries are in a highly advanced condition have an advantage over others. India's heavy industries were admittedly in a low stage of development before the war. We had a fairly large iron and steel industry but it did not produce the special kinds of steel required for armour plates, tools, wheels and axles, etc. Metals like aluminium, copper, lead, zinc and tin are essential for modern war, but the industries connected with them were either non-existent here or were in a very undeveloped state. Engineering industries working on a mass production basis are required for producing the various weapons mentioned above; but while India had a few Engineering firms for fabrication, they were ill-equipped for specialised lines of production especially on the mass scale. The plant and machine tools required were not available in the country; nor was there an adequate number of technically skilled persons to operate them. Especially in the conditions of 1942-43, it was not easy to obtain from abroad the machinery and meterial required.

Yet India has faced the situation manfully. In spite of serious handicaps regarding machine tools and essential components, large quantities of guns, tanks, bombs, and other ammunition have been produced during the last two years, and as a result solid progress has been made in various metallurgical, engineering and chemical industries. Not only has the Indian steel production capacity nearly doubled since the war broke out, but commendable progress has been made in the production of alloy steels, tool steels and other special steels, thanks mainly to the high technical equipment of the largest single-unit steel works in the world outside the U. S. A. The timely establishment of a new aluminium industry with great future possibilities is another achievement of which this country can be proud. Great credit is also due to those who, in spite of numerous difficulties, have set up various other non-ferous industries, all equally valuable in peace time as well as in war. In the field of engineering the progress in machine tools is the most significant; while before the war hardly 100 machine tools were made in India in a year, about 350 machine tools are now being made in a month. Commendable advance has also been made in electrical engineering industry, and India has come to supply a large part of her fans and lamps. Not less striking is the progress in shipbuilding and marine engineering and if in aircraft manufacture the advance has not been so great, we have at least laid the foundations of this new industry by promptly taking up assembly and repair. Great strides have been made in the production of lanterns and lamps, petrol cans and other containers and numerous other essential articles which, although not so spectacular, are of real importance for raising living standards in the country.

In the following pages a brief account of the industries mentioned above is given. These industries are dealt with by the Directorate General Munitions Production, and the two Directorates (shipbuilding and Repairs, Aircraft) which subsequently branched off from it. It may be noted that these are also (along with chemicals) the basic industries of India.

Even more than in the case of the industries dealt with in the first series (D. G. S.), the developments sketched in this report have been haphazard. Production had to be carried out with such machinery and material as could be obtained in India, or be imported from abroad in the difficult days of 1942-43. In several lines, production is of an improvised character, and it would be idle to pretend that such production can compete successfully after the war with imports from countries with well-established industries. Various measures of rationalisation, and some of safeguarding, may be required after the war and on these decisions will soon have to be made.

Industries involving complicated processes and requiring specialised machinery cannot be built up in a day. For the economical production of

bicycles and automobiles (for instance), various ancillary industries must be developed, and this pre-supposes a high level of engineering and technical skill. In both these directions, progress in India has lately been rapid, and this ought to enable this country to quicken its pace of industrialisation after the war.

ACKNOWLEDGEMENTS

The procedure adopted in the present enquiry was about the same as described in the last report dealing with the Directorate General of Supply. I am grateful to Major General E. Wood, C.I.E., M.C., the Director General Munitions Production, Mr. A. R. E. Lockhart, Additional Director General and other officers of the D. G. M. P. for their great help. My thanks are also due to Mr. S. A. Venkataraman, C.I.E., I.C.S., and Mr. J. M. Srinagesh, I.C.S. (of the Supply Secretariat) who greatly facilitated my work. The Iron and Steel Controller and his officers have helped me by readily answering my enquiries regarding certain points. To one not initiated in the technique of the heavy industries, special help was necessary, and I found Mr. R. A. MacGregor, C.I.E., Chief Metallurgist to the Government of India, a source of great assistance, and to him my thanks are due in a special manner. I was not able to devote much time to shipbuilding and aircraft, and had it not been for the help rendered by the Directorates General dealing with these subjects, it would not have been possible to include in the report even short notes on these two important subjects.

My first report was drawn up almost entirely from the information readily available in the Supply Directorate, Delhi, and it was definitely understood that I should not call for information from the industries themselves. In the result, the report on several industries had to be meagre, to my great regret. But at the D. G. M. P., Calcutta, I had a freer hand in regard to communication with the industries and I found this most helpful in obtaining data on the recent developments in important industries. I visited several factories and had discussion with the leaders of industries. I am thankful to them all for their generous help in regard to facts and statistics.

To survey, however cursorily, so many industries in so short a time has proved a rather strenuous task. When my work started at the D. G. S., my staff consisted of one stenographer. Subsequently I was permitted to have an Assistant, Mr. T. N. Kuriakose, the Assistant, has given me great help in my work, and I must thank him for his unsparing labours.

... ...

I shall be failing in my duty if I conclude this without expressing my deep sense of indebtedness to the Supply Member, the Hon'ble Sir A. Ramaswami Mudaliar, K.C.S.I., who initiated this enquiry and who gave me most valuable guidance in the course of my work.

15th August, 1944. P. J. THOMAS.

REPORT ON METALLURGICAL AND ENGINEERING INDUSTRIES (RECENT DEVELOPMENTS)

PART A—METALLURGICAL INDUSTRIES

Metallurgical and Engineering Industries.—We may begin by tracing the relation between metallurgical and engineering industries. Iron is the foundation of modern civilisation. We need railways and steam ships and various machines for our factories. In war time we require also guns, tanks and bombs and other ammunition. All these have to be made with iron and steel in engineering workshops. Together with iron and steel, non-ferrous metals like copper, aluminium, etc. are also required, although in smaller quantities. Thus metallurgical industries form the basis of engineering industries. For instance, in order to make a steel bridge, we require steel in the form of structurals, plates, bolts, nuts and rivets, castings etc. Steel is made in iron and steel works assisted by various ancillary industries like iron ore mining, refractory making etc. In the steel works, not only are steel ingots made but also structurals, rails, plates, sheets etc. But other more specialised steel products like wire and nail, steel castings, tin plate, bolts, nuts and rivets etc—all essential for engineering work—are made by the various associated industries. Further, the simpler needs of the rural folk have also to be catered for, and for this purpose the billets turned out by the big steel producers are converted by re-rolling mills into rods and bars for rural use. Thus around the iron and steel industry are many ancillary and associated industries, which either make raw materials for the steel makers or convert the steel made into something more readily usable by the engineering industries.

Engineering again has many ramifications. First and foremost, come machine tools and other machines and mechanical appliances. Next there is structural engineering, engaged in building various structures including bridges and æroplane hangars and derricks. In modern times various electrical goods have become essential for civilised life and therefore electrical engineering has come to occupy an important place. Welding and press work form yet another branch essential in many stages of the engineering work. In the construction and maintenance of railways, all these branches of engineering play a part. They also play some part in shipbuilding, but marine engineering has altogether different bearings, and the aircraft industry is even more completely marked out from the rest of the engineering field.

In the following pages, we will first give an account of the matallurgical industries which produce the basic materials and then pass on to the engineering industries which use them for making railways and steam ships, guns and bombs, lamps and containers, and other articles required for use in peace and war.

SECTION 1.—IRON AND STEEL INDUSTRY

1. The Main Producers

Before the War.—At the outbreak of war, India was making about 1,750,000 tons of pig iron in ten blast furnaces. Five of these belonged to the Tata Iron and Steel Co., Jamshedpur, four to Indian Iron and Steel Co., Burnpur and Kulti and one to Mysore Iron and Steel Works. Bhadravati, the proportion of each in production being 57, 41, and 2 respectively.

Of the pig iron made, about 60 per cent, was used for making steel in India, the remainder being exported or used in iron foundries in India. The exports went chiefly to Japan. U. K., U. S. A., Burma, Ceylon, Java and Africa. The finished steel made in India amounted to about 750,000 tons per annum. The Tatas was much the biggest producer. The remainder was produced at the Mysore Iron and Steel Works, Bhadravati, the Government Ordnance Factory, Ishapore, Kumardhubi Engineering Works and two or three electric furnace plants maintained by re-rolling mills. The first two—Tatas and the Mysore

Works—may be called primary steel producers because they made pig iron and converted it into steel, while the latter were only secondary producers, converting bought pig-iron and scrap into steel. The Government Ordnance Factory obtained hematite pig iron from the U. K. for making the superior steel needed for munitions production. Kumardhubi Works also got their iron from U. K. for making acid steels castings, and the electric furnaces got it from Tatas or from the India Iron and Steel Company.

The above were the principal firms engaged in producing iron and steel. In addition, there were about fifty re-rolling mills engaged in rolling steel billets and scrap into rods and bars. Their total output is not recorded, but it must have been about 50,000 tons per annum.

Besides the primary and secondary steel makers, there were a few plants which took raw steel from the primary producers and went one step further by converting it into something more readily usable by the various engineering industries. Among these were the Tinplate Company of India established in 1922 at Tatanagar. It bought steel tin-bar from Tatas and converted it into tinplates by rolling into thin sheets and adding a little tin-coating. Similarly the Indian Steel and Wire Products Co. converted steel into wire. Another firm, Guest, Keen, Williams, Ltd., took Tata's steel billets and rolled them into railway track fittings, and bars for bolts and nuts. Steel castings for engineering purposes were made by burn and Co., the Kumardhubi Engineering Works, and Hukamchand Steel Co. (Now called Bharatia Electric Steel Works).

In addition to the 750,000 tons of finished steel made in India, imports varying from 150,000 tons to 300,000 tons per annum were also coming in, thus raising total consumption to about one million tons.

Although steel production in India had made rapid strides since the last war, India's place in the steel producing countries in the world was extremely low as can be seen from the following table:—

Steel ingots and castings in 1939

Country	In thousand net tons
U. S. A.	52,798
Germany	29,617
U. S. S. R.	20,719
U. K.	15,119
France	9,407
Japan	7,055
Belgium	3,429
Canada	1,509
Sweden	1,231
India	750
Spain	560

It would be clear from the above that for a country of India's size and population, the iron and steel industry was still in an undeveloped condition.

The total value of India's steel production was not accurately computed, but Rs. 15 crores would be a reasonable estimate. To this must be added the value of the pig iron exported, and that used in India in foundries etc., estimated at about Rs. 4.5 crores.

Nature of the plant.—It is not proposed here to dwell on the technique of the steel industry, but a few points about the plants used may be apposite. The Tata Works are self-contained. They mine their own iron ore and fluxes. They smelt the iron ore in blast furnaces, one of which holds the world's record for one day's production. They convert pig iron into steel in Basic Open Hearth Furnaces, in a Duplex plant consisting of Acid Bessemer Converters and Basic Tilting Open Hearth Furnaces. Before the war, only one electric furnace, basic lined was worked. The peculiarity of the Mysore plant is that it uses charcoal instead of coal for iron smelting. Before the war, there was one basic open hearth furnace, and a few small electrically driven mills. The smaller steel producers used electric furnaces and small open hearth furnaces.

Although Indian iron ore is as good as any in the world, yet as it is smelted with coke obtained from Indian coal which is of poor quality and contains a considerable proportion of phosphorus, the resulting pig iron is of the basic quality, containing between 25 and 35 per cent of phosphorus. But this pig iron cannot be used in making the superior 'acid steel' and such steel alone is suitable for making guns, armour, etc. Therefore the ordnance Factory at Ishapore used special phosphorus-free hematite pig iron imported from the U. K. But only a small quantity of such acid steel was made in their small furnaces.

The Tata Works, however, made their superior qualities of steel by using an electric steel melting furnace and from this important developments took place just about the time of the outbreak of war.

Lines of Production.—As stated above, about sixty per cent of the pig iron made was used for steel making and the remainder was exported or went into railway castings. pipes and general engineering castings.

The steel production consisted of structurals, bars, rods, plates, sheets, corrugated sheets, rails, railway fittings, tinplates, wires, steel castings, nails, nuts and bolts, etc. At the Ordnance Factory guns. shells and armaments fittings were made. The approximate quantity of each of these in the immediate pre-war days can be seen from the table on page 8.

Steel consumption.—Even before the war, the largest buyer of steel in India was the Government, which own most of the railways and are responsible for the bulk of the public works in the country. About 40 per cent, of the total Iron and Steel production was absorbed by the Railways, C. P. W. D., etc. Besides such direct purchases, about 20 per cent, more was absorbed in the form of fabricated articles. Thus, even before the war, 60 per cent, of the total steel production was bought by Government. The remaining 40 per cent was taken up by the Indian States for Railway purposes, by the makers of agricultural implements and by purely civilian commercial undertakings, such as, house-building, water schemes, power schemes, expansion of engineering works etc.

Localisation of the industry.—The steel industry in India is located principally in the Behar Province. This location was decided chiefly by the availability of raw materials. The primary raw materials for the iron and steel industry are : iron ore, coal and water. Next come limestone (for iron and steel making). fluxes, silica rocks for refractory making, manganese and chrome ores for alloying with iron, and dolomite for lining steel furnaces. Iron ores are in abundance in Behar, Orissa and the Eastern States, Coal as found in Behar and N. W. Bengal. Luckily, the other raw materials above mentioned, are also found in that region. The minerals mentioned are probably the best in the world. Coal of good quality is limited in quantity and even the coking coal supply is limited. This is the one principal deficiency which India has to overcome.

The first centre of large-scale production was chosen as a compromise perfect iron-ore 60 miles to the south, coal a hundred miles north. But in the Indian climate water is a deciding factor. Consequently, Jamshed Tata selected a site in Chota Nagpur situated in the angle where two considerable rivers meet. The Steel Works of the Steel Corporation of Bengal is also situated where water is in good supply although it is further from its ore supplies, but compensatingly nearer its coal supply.

There can be no doubt that Chota Nagpur, and the extreme north-western part of Bengal are the districts where major steel works are likely to develop.

The Mysore industry is fortunate in having a most excellent ore at its door step, but it depends on wood-charcoal for its fuel. Its greatest advantage is that of freight. It is very far away from the two main producers and has the whole of Southern India for its market : yet it did not work profitably for long.

War-time Developments.—Napoleon said that armies march on their stomachs. It may be more approximately said of modern armies that they march on steel. The most decisive weapons of war —tanks, guns, ships and bombs— are all made of steel. Armies have to be equipped with steel weapons and have to be transported in steel-built ships or on railways working with the help of steel rails, steel bridges, steel wagons and other steel-made appurtenances Steel structures are needed for army accommodation. and steel in other forms is also needed for innumerable other purposes. Thus, steel is of basic importance even more in war time than in peace.

In the first year of war, however the extra demand for steel was not great. Till the middle of 1940, only about 30,000 tons of steel was used for direct war purposes, but by the end of 1940, military demands began to exceed this country's capacity for production.

Before the war, besides the local production of about 750,000 tons of steel, India had been importing large quantities of steel, which in the immediate pre-war years amounted from 150,000 tons to 300,000 tons per annum. While the Mediterranean route was safe, imports could continue, although on an attenuated scale; but after the fall of France and the entry of Italy Into the war, imports of steel necessarily declined, India was thus called upon to supply larger quantities of ordinary carbon steel, and in addition high-grade varieties like acid steel and special alloy-steels wanted for essential military purposes. As we will see, our steel producers rose to the occasion, but in spite of all their Herculean efforts, India was able to meet only 75 per cent. of her 1943 demands, according to the Anglow-American steel Mission, which visited this country in 1943.

Iron and Steel Control.—It thus became obvious at an early stage that such steel as was being made would have to be rationed out among the indenting Departments of Government. Consequently, a statutory control of iron and steel distribution was introduced, and this became effective from August 1941 Under the Iron and Steel Control Order, issued on 1st August 1941, the available Steel was allocated to the several military Departments. Railways and essential civil users in proportions fixed by the Master General of the Ordnance in India. Roughly 70 per cent. of the steel was earmarked for direct military purposes and the remaining 30 per cent was divided nearly equally between railways and civil demands. If Railway demand can be classed as military- and much of it is—only about 16 per cent. went to meet civil demands.

Increase of Indian steel production.—Even if India met only 75 per cent. of her 1943 steel demands, as stated by the Steel Mission (one fears that this is an under-estimate if by 'civilian demand' is meant the actual allocation), it is clear that a large increase in production must have taken place since 1940 this country was also able to supply high quality steels hitherto imported or not used at all. How was this rendered possible?

Fortunately various developments had been taking place just before and immediately after the outbreak of war, which made an expansion of production possible. Firstly, the older producers, like the Tata Works, had been stepping up production by various efficiency methods and replacements of plant, and secondly several new producers, including one large steel works, came into production about that time.

Steel corporation of Bengal —We will take up the latter first. The Steel Corporation of Bengal owes its origin to the Martin-Burn Managing Agency, which had also been responsible in starting the Indian Iron and Steel Company. The latter made only pig-iron, and was only second to the Tatas in that respect in India. This old established company gives to the new steel concern, SCOB, located in Burnpur, not only its pig-iron but also power. gas, water etc., and obtains a fixed percentage of its profits, The SCOB began to work with three basic open-hearth furnaces; the plant was planned in 1936 but came into operation only in November 1939. In 1942 an additional open-hearth furnace was installed.

Negotiations for the purchase of the necessary plant and machinery in Germany were made well before the war, but it was only just before the war broke out that they reached India, in British ships. German technicians engaged for installing the plant were at work when the war broke out and it is believed that before leaving the place they tore up the bule-prints prepared by them for the Company. In spite of such handicaps, the plant was soon in working order and steel production began in November 1939. When the full pre-war project is completed, the plant will consist of a number of basic open hearth furnaces to be supplemented by a Duplex plant, the whole of which will ultimately provide an output of between 500,000 and 600,000 tons of steel per annum. In the initial stages the capacity used was only for about 100,000 tons of steel per annum, but production has been stepped up and was well above that level before the coal shortage started.

A large part of output of SCOB has been used for shells, picket posts, rails for the Middle East, track parts' telephone equipment, containers etc. A toluene plant has also been installed, and this is turning to good account a bye-product which would otherwise go to waste,

Other new Producers.—Just before the war, about three of the re-rolling mills had set up electric furnaces to make steel from scrap. Since then six other re-rolling mills have taken up steel manufacture by the electric process and although the total quantity produced is not large, this has increased the capacity for high quality steels. (*Vide infra*). The National Iron and Steel Co., (Belur), which had already been working a 10-ton electric plant and a one-ton electric plant is now constructing a 25-ton open-hearth furnace. Two other 25-ton open-hearth furnaces are under construction at the Ordnance Factory Cawnpore. Two small open-hearths at the Ordnance Factory, Moradnagar, are also under construction.

Expansions at Jamshedpur and Bhadravati.—It is true that during the war the only considerable addition to the Tata Works has been the Perrin plant so far worked on the triplex process involving the increased production of about 60,000 tons per annum. (*vide infra*). But apart from this, in the years immediately before the outbreak of the war, important replacements and additions to plant had taken place as part of a large forward programme.

In 1939-40, one of the two old blast furnaces was replaced by a new 1000-ton blast furnace. A second gas-cleaning plant and a third mechanised unit of the sheet-mills (among other items) were added, and a magnesite plant for the production of pea-size magnesite and magnesite bricks was also constructed. Other important additions were the Lee-Wilson sheet annealing furnace, and the two Sandberg ovens for controlled cooling of rails. Subsequently, the Company brought into operation the Bensol plant and Ingot Mould Foundry. Two 5-ton electric furnaces were installed in 1940. Perhaps more important then all these the productive efficiency of the Works had been steadily increasing partly by the improvement of economic organisation, and during the war this was reinforced by the introduction of generous profit-sharing schemes which gave a powerful incentive for hard work among the staff and operatives, with the result that production in several lines reached record figures which will always stand to the credit of this great steel works.

Similar extensions were made at the Mysore Iron and Steel Works also. A 25-ton Basic Furnace installed during war-time along with two small electric furnaces will increase the productive capacity to above 50,000 tons, although this has not been fully utilized.

Some statistics.—The statistics of the Iron and Steel Industry have yet to be worked out and I understand that a large staff under the Steel Commissioner is engaged in rectifying this defect. In the meantime the following approximate figures may give rough indications of the developments in war years.

The pig iron production of India which amounted to about 1,750,000 tons in 1938 had risen to about 2 ,000,000 tons by 1943. But in the mean time the export of pig iron which amounted annually to 500,000 to 600,000 tons in the years 1938-39 to 1941-42 had gone down to 240,000 tons in 1942-43.

The production capacity for finished steel rose from about 750,000 tons in 1938-39 to about 1,250,000 tons in 1943-44 and is likely to reach 1,500,000 tons when the new projects are completed provided that coal and transport facilities are available in sufficient quantities. Evidently, the larger part of the pig iron made has been converted into steel and while the imports fell, more of pig iron must have been used for iron castings, the production of which has lately increased considerably according to all accounts.

The proportion of finished steel going into various items may be seen from the following table drawn up from the papers of the D. G. M. P.'s Office.

Steel production under various heads—pre-war and war.

	pre-war (Tons)	1944 (estimates) (Tons)
Structurals	150,000	225,000
Bars and rods	150,000	222,000
Plates	70,000	82,000
Sheets—black and corrugated	150,000	183,000
Rails and fishplates	120,000	149,000
Railway fittings	28,000	...
Tinplate	50,000	80,000
Wire	10,000	17,800
Castings	5,000	7,000
Nails	10,000	14,000
Nuts and bolts	5,000	29,000
Ordnance	2,000	30,000

Superior steels—The real test of the Indian steel industry in the war was not so much in quantities as in qualities of steel production, and in this respect also, the Indian steel industry rose to the occasion because it had been even before the war interesting itself in the production of quality steels, even alloy steels. In the last war, Indian-made rails carried troops and munitions to the front line. In this war, not only rails, but also whole wagons including wheels, tyres and axles are being constructed here and excepting locomotives, nearly, everything required for railways is being manufactured. Nor is this country providing merely the transport. She is now able to make also the armour plate and armour piercing steel required for the fighting forces whether in the army or navy.

Rails.—In the first years of this war also, a large demand for rails arose for use in N. Africa, Iraq and Iran. Apparently foreseeing this demand, the Tata Works had made, just before the war, important improvements in rail making, and in this its well equipped Research and Control Laboratory (established in 1938), has been of great assistance. With the help of electric furnaces, the Tata Works made, for the first time in India, high-grade carbon forging steels in bulk for railway purposes. It was this that enabled India to make high class panel plates for building railway coaching stock-hitherto regarded as an American preserve. Presently the same firm excelled itself by manufacturing railway spring steels, hitherto imported. Formerly Indian rails were mostly made in carbon steel or chrome steel, but with the production in bulk of medium manganese rails, these became the staple of the rail trade. The latest methods of controlled cooling of rails by the Sandburg process, have also been adopted by the Tatas. The progress in this line has been substantial and in the result Indian railways have become remarkably free from rail breakages in the tract. In this respect Indian rails can now stand a comparison with any in the world. The SCOB has also made excellent rails and India will have an ample supply of rails for pushing on railway extension schemes after the war.

Acid Steel—For various munitions purposes, some quantity of acid steel has been required in India. But the production of acid steel was hitherto impossible on a large scale, as the necessary raw-materials were not available in the country. As mentioned above, the Ordnance Factory, Ishapore had been making acid steel by importing hematite pig iron from the U. K. The military weakness of such dependence had been realised even before the war and when the Ordnance Factory was rebuilt in 1939, the scrap carbon process was introduced (i.e., using clean scrap low in phosphorus content). This enabled

the Ordnance Factory to produce in India the suitable steels for the manufacture of guns and other munitions, and this advance proved helpful in the critical conditions of 1941-42.

Perrin Plant.—As the passing need for making wheels, tyres and axles arose in India in 1941, larger quantities of acid steel at reasonable cost became necessary, and in 1942-43 a very important step in this direction was taken at the Tata Works by installing a plant for making acid steel by the Perrin process. This process was invented and first tried in France, but has not been fully developed there. In 1943, the Tata Works using its extensive resources laid the foundations of the Perrin plant, the first of its kind in the world. By using this process, a certain amount of steel on an experimental basis was also produced in July 1943. The advantage of the Perrin Process consists in the removal of the unwanted phosphorus in the ladle itself and not in the furnace as is attempted in other processes. Thus, by putting Perrin steel into the acid furnace, the process can be completed in a much shorter time and at a lower cost Some quantities of high silicon spring steel and boiler quality plate were also made in the acid furnace. Such steels had hitherto to be made in the electric furnace. Experiments on the Perrin process are continuing. In the meantime, acid steel is being made at the steel melting shop, No. 3, by a "Triplex" process, which is a combination of the converter, the basic open hearth and the acid open hearth.

Wheels, tyres and axles.—The production of acid steel by the triplex process has enabled the Tata Works to embark on the manufacture of wheels, tyres and axles,—essential articles for railway rolling stock, all of which had hitherto been imported from abroad. Although basic steel is considered suitable for the manufacture of wheels, tyres and axles in countries like America and Australia, it is not acceptable for this purpose by the Indian Railway Board who follow the British practice in this respect. A special plant for this purpose was brought into operation in November 1941, and with the increased supply of acid steel, it has been possible to take up the production of wheels, tyres and axles. This is expected to help in relieving the wagon shortage, which is partly the cause of transport difficulties lately experienced.

Alloy steels.—Perhaps the most significant advance in war time has been in the making of the alloy and tool steels required for special military purposes and for important civilian uses as well. Even before the war some low alloy high-tensile steel was made at the Tatas', but this was used mostly for bridge building and railway wagon work. Such was 'Tiscrom', the steel used for the new Howrah Bridge. This was the first time that such steel was manufactured in India.

When in 1940-41 India was cut off from the Allied Nations, the General Staff found in next to impossible to obtain armour plating required for that essential weapon of war—armoured fighting vehicles—and half in despair the demand was put to the Tata Works to produce some near substitute for it. But Tatas met the demand by supplying armour plating which stood the most searching tests. Experiments on bullet proof plates were made in 1940 and this demonstrated the possibility of manufacturing the special alloy steel required. Soon plant was laid, and not only armour plating but armour piercing steel was made. Thus, it became possible to produce as many as 5,000 Armoured Fighting Vehicles in India with chassis imported from Canada. (See Section VI). Had it not been for this quick achievement of the Tatas, it would have been difficult to have Armoured Fighting Vehicles for operations on the eastern front.

At first the production of these alloy steels came to only 250 tons per month, but rose to 500 tons early in 1941, and in 1942 production reached the maximum of 1,000 tons per month. Not only bullet-proof armour plates, but special alloy steel rivet bars for the fabrication of the armoured fighting vehicles and a special welding electrode used for the welding of the same vehicles were made by Tatas and this also facilitated the manufacture of this important arm of land warfare. At the same time special alloy steels were made for the proofing of armour piercing shot. Composite plates to withstand the attacks of 2-pounder shot etc. were also made. Other allied achievements

in steel-making were: high-speed steel for machine tools, high carbon steels for the manufacture of mint-dies, and other types of plain carbon steels for high explosive shells and for rolling sheets for Ordnance requirements. Nickel steel plates for gun carriages, and a special high alloyed nickel manganese non-magnetic steel, were developed for use in the manufacture of Service helmets, Stainless steels for surgical instruments were made for the first time in India.

Some of the alloy steels have been used in the manufacture and repair of aircraft and ships. A special alloy steel was developed by Tatas for parachute harness and for the parts used in aircraft. The same firm has also produced Admiralty "D" steels for ship-building. Some of the intricate castings made by Tatas (e.g. basset-type trawler bed plates) are now used for making certain essential parts of ships.

About the middle of 1943, Tatas installed a ½-ton high frequency furnace on behalf of Government. This furnace together with the existing two 5-ton electric furnaces, are being used for the making of special alloy and tool steels. A ferro-alloy plant with 4 electric arc furnaces for the production of ferro-tungsten was also started in April for the first time and 48 tons of ferro-tungsten was produced in 1943-44.

For meeting the requirements of ferro-vanadium, essential for the manufacture of certain grades of tool and alloy steels, a plant for the extraction of vanadium from the indigenous vanadium bearing iron ores was established.

Thanks to these developments, it has been possible to make high speed (tungsten) tool steel and hot die steels and other varieties of tool steels for mint dies, punches, shear blades, pneumatic tools etc. Such steels will be of vital importance to the post-war industrial development of India.

When the alloy-steels were first made, it was not possible to give the heat-treatment required. But, since then the Tata plant has equipped itself for giving any heat treatment necessary, such as quenching, tempering, normalising, annealing etc. and it is able to supply alloy steel in heat-treated condition.

Metallurgical Research.—In addition to the manufacture of the special steels mentioned above, experiments have been conducted in the Tata Control and Research Laboratories on the manufacture of ferro-titanium, ferro-boron and ferro-phosphorus, and exploratory work has been done on the electrolytic polishing of ferrous and non-ferrous micro samples. Attempts have also been made to develop welding rods for vertical and over-head welding and investigations conducted on the corrosive action of vanadic acid on different iron and steel alloys.

Spectro-chemical analysis of iron and steel and calorimetric analysis of molybdenum and nickel have been carried out and suitable methods of analysis of minute quantities of boron in steel have been developed.

As a result of researches in the same laboratories, it has been possible to manufacture basic refractories from low grade chrome ore, nozzles and stoppers from clays obtained from Company's properties, substitute bricks for mica-schist in lining Bessemer Converters and replace silica bricks by unburnt magnisite for the purpose of lining electric furnaces, and develop high temperature mortar for pointing coke-ovens in place of foreign mortars used previously.

Estimate of Results.—The developments just enumerated have not only helped the country at a critical time when imports could not be obtained, but have also strengthened the country for tackling similar situations effectively in future. The extent to which India has become self-supporting in regard to the steel and engineering industries generally has not been fully realised. One instance of this advance is the part construction of a large billet mill by the Tatas in their own shops with only a fifth of the necessary machinery and equipment imported from outside. Another steel works has built its own smaller rod mill, whilst a third mill put into operation its own built bar mill. All these are achievements of which any country can be proud, especially as they have been carried out within a very short time.

It is true that recent developments were made in connection with war requirements, but it may be noted that very little of the Indian steel production is

made in plant of a highly specialised war nature, and it follows that with a minimum of change in the steel works the production can be diverted from war purposes to civilian uses. In fact, except in the case of the Ordnance Factory at Ishapore, almost the entire steel plant in this country can be switched on to civilian production without notice.

The result of such developments has been manifold. Firstly, these have led to an expansion of the industries ancillary to the steel trade and associated industries. Secondly, The essentials for establishing important new industries are being evolved. The former will be dealt with in the subsequent sections. On the latter a few illustrations may be given here.

Experiments in the making of electrical steel sheets possessing special magnetic properties have shown that these sheets could be used in the special shapes required for the manufacture of electrical transformers, motors and fans. Similarly, experiments made in magnetic steels lately give indications that an impetus will soon be given to telephone, telegraph and radio manufacturing industries. High tensile wire has been made in the country although in small quantities and this may be expected to pave the way for making wire rope and wire spinning and a host of high tensile wire products.

The making of high-carbon tool steel has already resulted in the expansion of twist drill manufacture. This may also lead to the establishment of such industries as razor blades, files, cutters, knives, dies, saws, etc. The steels needed for making razor blades and hacksaw blades have already been manufactured on a small scale at the Tata Works. India has also made some of the special alloy steels used for motor and aircraft trades. So far only the smaller machines and machine tools have been made in India. As the forging trade grows, special steel forgings of any size can be made and this would facilitate the construction of major machine tools and heavier machinery. When the larger machine tools become available, It would also be possible to machine the larger forgings required in the heavy marine engineering industry. In the meantime, advance must also be made in intricate castings. A great deal more of technical skill than is now available in India will be needed if such possibilities are to materialize.

Evidently the whole development is of a cyclic character. When more and more specialised steels become available, new industries will develop and the development of new industries will call for, further acceleration of steel production and for the expansion of ancillary and allien industries. This upward spiral once started is bound to go on leading to economic development all round.

Post war Prospects

From the foregoing survey it is clear that the iron and steel industry has greatly expanded under the stress of war demands. Its total production has nearly doubled, and alloy steels and other superior steels have been made for the first time in the country. As shown above, these new lines of production have not only met essential war requirements, but have also laid the foundations for important new industries like machine tools, ship-building, automobiles. etc. Not that India has become self-sufficient in the matter of steel; imports of high-grade steels will still be required from the more technically advanced countries. India may still have a long way to go before she could meet the British and American specifications in respect of tolerances, heat treatment, etc. But this country is on the right path to a stable advance, and if the present pace of progress is maintained, India will soon take her proper place among the steel-making countries of the world.

Before the war, steel production in India depended on one very large producer at the top, with two or three small units at the bottom. This position was considered unsatisfactory by the Iron and Steel Tariff Board (1934). This defect has been removed by the establishment of a large steel plant by the Steel Corporation of Bengal, with a production Capacity which is only next to that of the Tata Works. Subsequently some of the rerolling mills have become special steel producers by setting up electric furnaces, and their total production capacity is already above 50,000 tons per annum (excluding steel castings.)

Thus Indian iron and steel industry has spread out both in quantity and in quality. Judged by the number of labourers employed and other usual tests, certain other Indian industries may appear more prominent; but as a basic industry, the iron and steel stands unrivalled, and as industrialisation advances, its importance is bound to grow.

The transition from war-time to peace-time production need not be a difficult process in the case of the steel industry, because very little of the production comes out of plant of highly specialized war nature; except in the case of the Ordnance factories, almost the entire steel plant in this country can be switched on to civil production without any serious re-adjustment.

Nor is there much ground for pessimism in regard to the large quantities of steel now going into war effort not finding a ready market in peace time. Although war demands have brought about a doubling of the steel production from 750,000 to 1,250,000 tons per annum, yet it may be remembered that India's pre-war consumption of indigenous and imported steel was about 1,000,000 tons per annum. The absorption of this extra 250,000 tons of steel will not be a difficult matter in view of the inevitable surge of civil demand after the war. Railway renewals, road and bridge works and other public works held up during the war will also call for large quantities of steel. At any rate for a few years after the war, there is greater chance of supplies being inadequate to meet the internal demand and it is doubtful if we will have anything for export to the neighbouring countries, which look to India legitimately for their steel supplies. It may also be remembered in this connection that India had been exporting from 500,000 to 600,000 tons of pig iron annually before the war. If this export trade revives, steel production might in the meantime even diminish unless extra capacity for making pig iron is created.

Thus India's present level of steel production may not be found a surplus in the post-war years, in the normal course of things. On the other hand, if anything like an active post-war plan of the type lately contemplated is taken up, demands on the Indian steel industry would be so great that a serious problem of steel shortage may arise. For instance, any economic development plan would require more roads and bridges, large construction works and various kinds of public utility concerns. All this would call for large quantities of steel in the form of structurals, rails, sheets, bars, wire and nails, fastenings etc. The problem of increasing the steel production will then face the country in all its seriousness. How could this be tackled ?

When one views Indian iron and steel industry, certain strong points stand out. India has almost unlimited resources of high-grade iron ore, manganese ore, chrome ore, limestone, dolomite and magnesite. Excellent clays and silicon rocks are found in the country and these have already been manufactured into high quality fire-bricks and silicon bricks used for lining steel furnaces.

India has been producing pig iron of high quality at comparatively low costs and the fact that this found a ready market in the U.K., U.S.A. and Japan in spite of various obstacles, to trade shows that in this respect India is on the strong-side.

For the making of ordinary basic steels also, India has nearly everything required. One deficiency is that our iron ore is not suitable for making acid steel owing to its high phosphorus content. But even now the bulk of the steel made all over the world is basic and only a small part of acid. Nor is there any unanimity in regard to superior quality of acid steel for various uses to which it has been put in the past.

The two bottlenecks which India has to tackle are in regard to the inadequacy of coking coal and the high cost of transport. Both these have lately affected us materially. Viewed from one angle, these two bottlenecks merge into one because coal is also the essential basis of railways transport. It takes about ten tons of raw materials and stores to make one ton of finished steel and as distances for distribution are also great in India, the transport-cum-coal difficulty is rather complicated. This cannot be discussed in any detail in

this report. A few salient points may however be dealt with. India's supplies of coking coal are very limited. Yet they have been wastefully utilised for purposes for which inferior coal would suffice. One step which may be taken in this connection is to electrify the railway by the use of cheap electric power generated from hydro-elctric resources of from low grade coal Both will help to economise the use of coal. The cheap power thus provided can also be used for steel production in electric furnaces. If by setting up such steel furnaces in many parts of the country, the common needs of each locality can be met, the demand for long distance railway transport can be considerably curtailed. Further, with the help of steel furnaces, superior steels can be manufactured and the deficiency in this respect can also be rectified. Thus the generation of electric power may be helpful in every way to meet our present difficulties.

A notable deficiency in India's steel production is the gross inadequacy of the forging industry. During the war, the Ishapore Ordnance Factory and the new Ordnance Factory at Cawnpore had been equipped with excellent forging presses. Both these factories may not de required for military purposes after the war, and therefore it may be possible to place one of them on a commercial basis and develop it as the nucleus of a medium-heavy forging industry.

A start has been made in the country for the production of special alloy steels, tool steels,etc. Tatas have a plan for the construction of a consolidated alloy and tool steel plant. SCOB has also plans for making alloy and tool steels. Such plans deserve encouragement in view of the importance of such steels in peace-time as well as war-time industry.

Tatas have also plans for the erection of a special furnace for facilitating the production on a commercial basis of electrical sheets for transformers, motors, generators and electrical machinery so far made only experimentally on a small scale. Even more noteworthy is their plan for the manufacture of boilers and locomotives. It may take some time for the latter plan to materialise, but when it does, it would open out possibilities for far-reaching industrial developments.

2. Re-Rolling Mills

The first re-rolling mills were engaged in rolling the scrap accumulated in railway workshops. Subsequently a better class of scrap was imported and billets were purchased from the main steel makers, and these were rolled into useful sections and bars required for construction and other purposes. Twenty years ago, there were only two or three such mills. From 1935, largely owing to the feverish rearmament boom in Europe, the industry got a fillip,and by 1940, the number of mills rose to about fifty. In that year a Re-rolling Mills Association was started mainly for protecting the members from the unfair competition of the main producers. Of the fifty mills then in existence, only about twenty-five were admitted as members. A little later the remaining twenty-five were admitted as B Class members.

In the latter part of 1941, the war demand for steel became so heavy that the whole production of the re-rollers was bought for military purposes. This abnormal demand encouraged the establishment of new mills and there arose as many as 150 re-rolling mills of all sorts and conditions; of this only 100 have been admitted to membership of the Association, while the other 30 are so small that they themselves do not aspire to membership.

The benefit which the ordinary member received from the Association was a share in the available scrap. The scrap originates in the course of ordinary production in the two large steel works and as the Chairman of the Association was Tatas, Sales Manager, he was able to control this source of scrap. Further, scrap was being thrown up in the course of the manufacturing operations undertaken for the D.G M.P. Such scrap also was distributed among the members of the Association

Taking advantage of the abnormal war demand for special steel products, the older and better equipped of the re-rollers took up the manufacture of special steel products (these formed the A-1 class) or made steel by the electric process and set up foundries (these formed the A class). In this way both

these classes of mills tried to keep out of competition with the larger producers, and as the Government needed their products, they were given technical assistance in the new lines of production taken up. They have thus become fairly well established and have a definite place in the steel industry of India. As this is largely a war time development, some account of this may be given here.

Specialist steel manufacturers: A-1 class.—There are four re-rollers of this class they are working on a close complementary relationship with the larger steel producers, and they have not taken up the production of steel.

(i) *Indian Steel & Wire Products Ltd., Tatanagar.*—This company has a first class German mill which was primarily intended to roll wire rod but also rolls rods under ½" diameter by arrangement with the Tata Iron and Steel Co., who do not roll below ½" . The mill has a capacity for rolling about 50,000 tons of billets a year. (See under "Wire and Nail Industry").

(ii) *Guest, Keen, Williams.*—This company has been in existence for over 15 years and possesses special re-rolling mills which are fed by Tatas, SCOB or imported billets to the extent of about 30,000 tons a year. Practically the whole of the products of this mill are used within the works for the manufacture of nuts, bolts, rivets and a large variety of railway fittings. They are also the makers of railway spring flats. The company is at present engaged in installing an additional plant which will double its output of nuts, bolts and rivets.

(iii) *Indian Rolling Mills, Negapatam*—This mill is an up to date high speed mill installed shortly before the war broke out. the original intention was that two electric furnaces should be installed and although these two furnaces were delivered, they were never put into operation they were bought by Tatas in 1940 and were set up at Jamshedpur. After going through some difficulties, this mill entered into partnership with Tatas and is being fed with Tata billets. It is specializing in the manufacture of wire rod and cotton-baling hoops.

(iv) *Eagle Rolling Mills.*—This is an off-shoot of the Kumardhubi Engineering Works (of which see later). This mill has been leased by Tatas and is engaged in rolling small sections, not made by Tatas, from Tatas, billets. In 1942, this mill was engaged very largely in completing a contract for some 25,000 tons of bars and light structurals intended for supply to Turkey. This contract was finished long ago, and since then the mill has made very large quantities of light angles which are used by the Military as picket angles.

'A' Class Re-rollers.—This class consists of about a dozen mills which have been established either in pre-war days or in the very early days of war. They are equipped for turning out bars and flats of the quality suitable for war purposes. A few of these mills had set up electric furnaces even before the war to make steel from scrap. Others have taken up this work lately and to-day eight of them have electric or open-hearth steel furnaces. They can be considered as secondary steel producers. Formerly they made only mild steel. Some of them have since gone on to high-carbon tool steel making in considerable quantities. With a steady increase in the demand for steel, they may develop into fairly large steel producers. The following mills are included in this category.

1. *The National Iron & Steel Co., Ltd., Calcutta.*—This is one of the earliest re-rolling mills in the country. It has installed a 10-ton electric furnace, and a 1-ton electric furnace. and are at present engaged in building a 25 ton basic open-hearth furnace. The steel output from these furnaces has mostly been rolled down into bars and flats, but at the same time a fair sized steel foundry has been developed which is also taking steel from the above furnaces. From the mill products the company is also making nuts, bolts and rivets on a small scale, and they are also drawing wire. Several, other developments in the form of bright drawn shafting. and steel wire ropes are in contemplation. This company makes its steel in the electric furnace from scrap which they buy either from the main producers or from scrap merchants. The basic open hearth when in operation will use a fair quantity of pig iron which will have to be obtained either from Tatas or from the Indian Iron and Steel Co.

2. *Bhartiya Electric Steel Co., Calcutta (formerly called Hukamchand and Sons).*—This plant came into operation about 1922 solely as a steel foundry. It has 3 electric furnaces from which steel is made. Surplus steel in the form of ingots is handed over to the associated company who has a small re-rolling mill. This company is capable of making a number of special steels such as spring steel, rivet-bar, etc.

3. *Kumardhubi Engineering Works.*—This mill, originally set up at Pondichery, found its way subsequently to Kumardhubi. About the year 1938, the Eagle Mills were separated from the Engineering Works and were taken on lease by the Tata Iron & Steel Co. At the Engineering Works, there are 2 small open-hearth furnaces, engaged in feeding the company's steel foundry. In pre-war times the company was engaged in making engineering castings, but latterly its foundry has been very successful in turning out aerial and trench mortar bombs in large quantities. (See under castings.)

4. *J. K. Iron & Steel Co., Cawnpore.*—This mill was erected shortly before the war broke out and it possesses a 5-ton electric furnace which was installed at the same time. The whole plant is of German manufacture and was originally intended as a specialised mill, rolling cotton baling-hoop. It may be stated that this mill is a part of the large Juggilal Kamlapat organization and the products were primarily intended for use within that organization. Lately the company has extended and is at the present moment installing a steel foundry This will work in combination with the above electric furnace.

5. *Singh Engineering Co , Cawnpore.*—This mill is also one of the earliest re rolling mills in the country. Its products are ordinary bars and flats, but since the war broke out the company has installed a 5-ton basic open-hearth furnace the ingots from which are being rolled in the original mill.

6. *Steel & General Mills. Lahore.*—This company possesses an excellent mill and a 5-ton electric furnace. It produces ordinary bars and flats in the rolling mill. There is also a steel foundry which is served by the electric furnace.

7. *Mukund Iron & Steel Co., Lahore.*—This Company owns a rather old rolling mill, and has installed a 5-ton electric furnace. The cmpany is at present engaged in reconstructing the whole of their plant on modern lines. The company has a fairly large steel foundry served by the electric furnace and it is the company's intention to take on several specialised products such as files wire, etc., made from products of the rolling mill.

8. *Mukund Iron & Steel Co., Bombay.*—The same company maintains also a re-rolling mill at Lahore, with a 5-ton electric furnace. It is producing bars and flats from the mill and steel-castings in the small foundry.

9. *Hume Pipe & Co., Bombay.*—This firm has specialised in the production of reinforced concrete pipes of which it makes very large quantities. In 1943 the company installed a 3-ton electric furnace and a small rolling mill with wire drawing benches. The steel made in their mill is drawn into wire, and is used exclusively for re-inforcing the concrete pipes made by the firm.

The other mills of this class use either billets from the main producers or use scrap and convert them, as already stated, into goods saleable ordinary products, namely bars and flats.

'B' and 'C' Class Re-rollers.—This class of re-rollers comprises the majority of re-rolling mills in India, about 90 in number. They vary widely in capacity and their plants vary from reasonably good to very poor. More than half of them have sprung up since 1940-41. Generally speaking they use scrap as their raw material and their products, in the form of bars and flats, are suitable for agricultural purposes and ferro-concrete work. The village blacksmith to a large extent relies on the products of these two classes of mills. Generally the difference between B and C classes is simply that the B class has a larger production capacity Many of the C class mills have a very limited monthly output amounting to 100 tons or less.

The present situation

As mentioned above, there was a great demand for the re-rollers' products in the years 1941 and 1942. But by the middle of 1943 this demand had fallen

almost to the vanishing point. Subsequently, early in 1944 transport difficulties and the shortage of coal began to effect the steel industry as a whole, and re-rollers as well as the main producers were hit by this. It then became evident to the Government that the most efficient use possible was to be made of such transport and such coal as was available, having regard to the essential nature of the war demand. The coal resources and transport agencies being limited, it was found necessary to allocate them to the two main producers and such of the re-rollers as were making specialities. This matter came up before the Steel Commissioner and a decision by the Government is pending.

It is claimed by the re-rolling interests that out of the 250 000 tons of coal available for the steel industry, the re-rollers should be given their quota on a capacity basis. As against this it has to be pointed out; (1) that owing to comparatively inefficient methods of production employed by a large number of the re-rollers, their coal consumption is too high and therefore the allocation of coal to such re-rollers would be wasteful. (2) This argument has great strength especially in times of war like the present when all available resources should be economically utilised, in the best interests of war effort. (3) The argument gains further strength by the fact that re-rollers of the B and C classes are not making products which are directly for war purposes. (4) Finally it may also be pointed out that the re-rollers who started work in 1941 were warned by the Hon'ble Member for Supply at the very beginning that no guarantee of raw material could be made to them. It was in spite of such warning that numerous mills came into being in 1941.

The Future

That there is still need for re-rolling mills is undoubted. The claim put forward by the Tariff Board in 1934 on behalf of the re-rolling mills is still more or less valid. As for the specialist re-rollers (A-1 and A classes) no special case need be made out. They are needed now, and they will be needed after the war. The ordinary mills engaged in working up scrap into plates and flats for bazar use and for agricultural implements are also needed in the national interest, because the demand for such material in so vast a country like India cannot be met by the larger producers alone. There is a vast rural demand in India for iron and steel which has largely to be met locally and all the reasons urged by the Tariff Board in 1934 in their favour still operate, the only difference being that at the present moment we are compelled to make the best use of transport facilities and coal resources so that the greatest help may be given to war effort, which is the supreme concern today.

The question therefore is how to keep the more efficient of the re-rolling mills in production so that they may survive the present emergency. It is not denied even by the Re-rollers' Association that a good number of the mills owes their existence to the present abnormal conditions and that their chances of being able to continue in production when normal conditions return are small. A proposal being considered by the Association if the formation of a company with a capital of 3 to 5 crores, primarily intended for the building of a steel works which would smelt iron ore, make steel and produce billets for distribution among its members. It has been suggested that the capital of the proposed company should also be used to rationalise the re-rolling industry and that the small inefficient mills should be bought by the company. The scheme is, however, only in its initial stages. Any such scheme of rationalisation as envisaged by its promoters cannot be successful unless the Government by legislation prevent more re-rolling mills from coming into existence without licence from the Government.

The above scheme is in some ways analogous to the "Ship Builders' Securities" formed in the U. K. after the last war under the Chairmanship of Sir James Lithgow. During World War I, large numbers of ship-yards had come into existence all over the U. K. Coast, and the undercutting by them after the war brought prices down to an uneconomical level. Then Sir James Lithgow, suggested the formation of a company by the old established ship-yards entitled "Ship Builders' Securities". This company bought up the

mushroom ship-yards and effectively carried out rationalisation in the industry with the help of the Government.

3. Ancillary Industries

There are various industries ancillary to steel production. Several raw materials other than iron ore and coal are required in the manufacture of steel and as steel production advances, the supply of such raw-materials is bound to develop into important industries. The principal industries coming under the category are: (1) Refractories and (2) Ferro-alloys.

Refractories.—Iron ore smelting furnaces (Blast Furnaces) and steel-making furnaces have to be lined with special bricks made of various kinds of refractory materials. Fortunately most of these are available in India, in the areas adjoining the steel manufacturing centres. The processing of these bricks and other refractory materials has lately expanded and new industries are thus growing up in various parts of India, thereby giving employment to a large number of people. The following are the chief refractories required :—

(i) *Silica bricks.*—These are made from Indian materials quarried in the Dhanbad and Jubbalpore areas. The raw materials available are of a very high quality.

(ii) *Fire bricks.*—These are also made from indigenous materials in the same districts as above and they are of good quality.

(iii) *Magnesite bricks.*—Magnesite for these bricks are found in Salem district (South India) and the deposits are of a very high quality.

(iv) *Dolomite.*—This is a kind of lime magnesium carbonate and is used for making basic steel furnace hearths. It is available in India in good quality.

(v) *Silica sand.*—This is used for making hearths of acid furnaces. It is in sufficient supply in Jubbalpore area and the quality is acceptable.

These refractories are supplied by certain pottery works scattered about the country. Although the principal demand for refractories is from the iron and steel industry, they are also required in engineering works for lining the furnaces, for boilers in power stations, in Railways for lining locomotive fire boxes, and some are required in the pottery works themselves. Since the war began, ordnance factories have a greatly increased demand for refractories.

The principal manufacturers of refractories are the following :—

(1) Burn & Co. This company has refractory and pottery works at Jubbalpore (C. P.), Raneegunge, Gulfabari, and Durgapore (Bengal).

(2) The Reliance Fire Brick and Pottery Works Ltd. This company, with works at Chaunch makes acid proof ware for the manufacture of cordite and explosives, as well as synthetic insulating bricks.

(3) Kumardhubi Fire Clay and Silica Works (Kumardhubi).

(4) The Bihar Firebrick and Pottery Works, Mugma, E. I. R.

(5) The Tata Iron and Steel Works manufacture a certain quantity of magnesite and chrome bricks in their plant, for their own use.

There are several other small refractory works, which mostly meet the demand for ordinary firebricks.

Silica and magnesite bricks are manufactured by Burn & Co. and Kumardhubi Fireclay and Silica Works only.

Output.—The estimated consumption of refractories is as follows :—

Fireclay bricks—95,000 tons.

Silica bricks—25,000 tons.

Magnesite bricks—4,000 tons.

Chrome bricks—1,500 tons.

The industry has had great progress since 1939, and the present production must be at least 30 per cent. above the pre-war levels.

About 20,000 people are employed in the refractory industries. This number excludes people employed in the clay and quartering quarries who may be about 5,000.

The industry is a Well-organised one and it maintains high standards of production, comparable to those of Europe and America. The blast furnace linings and coke oven linings made in India have established a world record for length of life. The principal obstacle is regarding the transport and labour situation which has lately arisen.

Ferro-alloys.—All steel manufacture requires some ferro-alloy addition. The simplest ferro alloys are ferro-silicon and ferro-manganese. In pre-war days, India made all her ferro-manganese from the manganese ore of the Central Provinces. Not only is this ore sufficient for our uses; we are in fact exporting as much as 1,000,000 tons every year to the U. K. and U. S. A. But India has no ferro-silicon and until lately the whole supply had to be imported. In 1943, the Mysore Iron & Steel Works installed 2 ferro-alloy electric furnaces. The intention was to use one for the manufacture of ferro-silicon and the other for the manufacture of ferro-chrome. But the war situation demanded that both the furnaces should be put on to ferro-silicon, because the amount of ferro-chrome used in India is only about 500 tons per annum, while the requirements of ferro-silicon are about 4,000 tons per annum. It was therefore, considered good policy to make as much ferro-silicon as possible within the country and to import all our ferro-chrome. The Mysore furnaces will make about 2,000 tons per annum and we will still be dependant on imports for the other 2,000 tons.

(i) *Ferro-chrome.*—There are large deposits of chrome ore in Mysore and Bihar and these of good quality. But, so far these have not been converted into ferro-chrome. As mentioned above, the Mysore Iron and Steel Co. erected a furnace for this purpose, but this had to be diverted for ferro-silicon. Thus, all ferro-chrome continues to be imported, when required for special steel.

(ii) *Ferro-tungsten* —This is used in the manufacture of high speed steel. Its ore, wolfram, occurs in India in sufficient quantities for present needs. At one time, owing to world shortage, it was considered essential that India should 'reduce' her concentrates. Consequently, a large reduction furnace was ordered from America, but the U. S. A. is unable to supply the furnace owing to a complete change in the war supply of ferro-tungsten. Experiments, however, were carried out on a fairly large scale at Jamshedpur and some 50 tons of ferro-tungsten were made from kutcha furnaces. These have since been closed down and ferro-tungsten is being imported from the U. K.

(iii) *Nickel.*—It is used as an alloy in bullet-proof plate, armour piercing shot and numerous other steels for war time purposes. There is no nickel ore in India worth mentioning, although there is some in the neighbourhood of Nepal. All nickel requirements are now imported from Canada.

(iv) *Ferro-vanadium* —This is used in certain special alloy steels and high speed steels. Large quantities of a lower grade vanadiferrous magnetite ore exist in the Mayurbhanj State. A factory has been erected in that State to extract vanadium oxide from local ores and this is likely to come into operation by the middle of 1944.

(v) *Ferro-molybdenum.*—This is used in the manufacture of bullet-proof plate, gun-steels, high speed steels, etc. The ore from which this is made does not occur in India so far is known. We are dependant on U.S.A. for our supplies of this ferro alloy.

Fluxes.—The fluxes required are :—

(a) *Limestone.*—Fairly large quantities of this are available in Ranchi hills, near Chaubasa ; and

(b) *Flourspar.*—This is used in small quantities in basic furnaces. At present we import the whole quantity mostly from South Africa. A deposit has been located in India, but the quality is poor and the quantity small. The total quantity is about 500 tons a year.

4. Associated Industries

(a) *Tinplate*

General.—Tinplates or tinned sheets are mild steel sheets coated with tin of varying thicknesses. The lower quality grades having a thin coating of tin are called the 'coke' finish and the higher quality grades with thicker coatings are called the 'charcoal' finish. The unit of measure of tinplate of light gauges is the 'base box' which is the area represented by 112 sheets of size 14 inches by 20 inches, or approximately 218 square feet. The heavier gauges or tinned sheets are sold by weight. According to the grade and depending on the gauge, the tin coating ranges from about 1.25 lbs. to 2.75 lbs. per base box in the coke finish grades, and from 3 lbs. to 7 lbs. per base box in the charcoal finish grades. Thus the total weight of tin used is less than one fiftieth of the weight of steel, and hence tin plate can properly be considered as a steel product rather than as a tin product. Tin by itself, apart from being very costly, is too soft for the purposes for which tinplate is used.

Tinplate is chiefly used for the manufacture of containers or 'tins' as they are popularly called, for kerosene oil, petrol and other kinds of oil. It is also required for containers of various other articles of daily life like cigarettes, biscuits, fruits, tea, coffee, butter, ghee, vegetable oil etc., as well as for the manufacture of articles such as lamps and miscellaneous articles of the bazar like plates, cutlery, toys and the like.

The world's centre of tinplate industry is South Wales which has the advantage of a class of workers with hereditary skill in this manufacture. In the closing years the 19th century, America began this industry with the help of a large number of skilled workers hailing from Wales, and aided by protective duties, the industry has been established firmly.

Before the War

The whole of India's requirements of tinplate which came to about 50,000 tons annually was met by imports before the last Great War. But during 1914—18 the imports were almost entirely cut off and the distribution of kerosene, petrol and vegetable oils was very seriously disorganised. This led to the establishment of the industry in India immediately after the war. This was possible because of the convenience of obtaining steel bars from the newly opened Tata Iron and Steel Works. The Tinplate Company of India established in 1919 is conjointly owned by the Tata Iron and Steel Company and the Burmah Oil Company, the latter holding two-thirds of the capital The Managing Agents of the Company are Messrs. Shaw Wallace and Co., of Calcutta. The factory began working in 1923. It is located in Golmuri, near Tatanagar, and consists of 6 mills, all of which were in working order by 1924.

The Company began its work in 1923 with about 90 covenanted men specially got down from Wales. They constituted the entire labour force of the two mills started at first. But in one year's time a sufficient number of Indians were trained to operate the other four mills. In subsequent years dependence on foreign workers declined, so that, by 1932, overseas employees were only 23, being less than one per cent. of the total labour force. This has not been at the cost of quality. On the contrary there has been a corresponding improvement in the number and variety of gauges produced. The cost per ton has also been reduced to an extent more than warranted by the fall in the price of tin and steel since 1932, indicating a growing efficiency of labour and management. This was possible largely because of the protection enjoyed by the industry from the start, and because of the market assured by the purchases (under agreement for 25 years) of the Burma Oil Company.

Raw-materials.—The two important raw materials are steel sheet bar (tin bar) and block in. Tin bar is itself a semi-finished product, rolled into bar from the steel ingot to a definite analysis and specification. In 1927, the Company entered into an agreement with the Tata Iron and Steel Co,, for a period of 21 years for the supply of a maximum of 60,000 tons of tin bar a year at a fixed price, which was Rs. 83 per ton till December 1936. Tin which is

required in its pure form was obtained from the smelting companies of Singapore and Penang. In 1937, the Company used 900 tons of tin for its total annual output. Besides these two raw materials proper, many specialised items of equipment and stores are needed to manufactures tinplate such as chilled rolls for the hot and Cold Rolling Mills, annealing boxes, palm oil, zinc chloride etc. All these were coming from abroad. Sulphuric acid is also required, and in large quantities too, and is being manufactured by the Company in its own factory from imported sulphur.

Process of manufacture.—The manufacture of tisnplate consists of three essential processes, the rolling of the steel bar into heets, the preparation of these sheets for tinning, and their actual coating with tin. In the first process, the steel bar, $\frac{1}{2}$ inch thick is reduced by the alternate heating, rolling and doubling to the required thinness of the finished tinplate, which may be 12 thousandths of an inch as for the kerosene tin, or less, as for biscuits or cigarettes, or more, as for the petrol can. In this department, apart from climatic considerations, the work is very arduous and requires considerable skill and experience. The steel leaves the rolling mills in packs of 8 sheets about 60 inches long and 30 inches wide, which are then sheared to size and separated by hand. After pickling in dilute sulphuric acid to remove scale and after annealing in a continuous furnace in order to render them pliable, the sheets are rolled cold under high pressure to give them a suitable surface for the tinning process which is prefaced by a second pickling. The tinning machines are automatic, the plates passing successively through zinc chloride (which acts as a flux) molten tin and palm oil, and are finally cleaned in a dusting machine as they pass into the warehouse, where they are slit to size, sorted according to quality and packed for despatch to the customer. The machinery installed at the factory is of American manufacture and the Hot Mills are designed on the American pattern to give an output per pair of rolls equal to three or four times the output of a Welsh Tin Mill. Hence the rolls have to be very much larger and heavier than the rolls used in Wales. Such rolls were obtained from U. S. A; now rolls from U. K. are also proving satisfactory. Annually about 110 Chilled Rolls were imported for sheet mills.

Production.—The remarkable progress made by the industry during the period prior to World War II is indicated by the expansion of production of the factory and the extension of the gauges of its manufacture. The target of production for which the plant was originally designed was only 28,000 tons of tinplate annually, but by 1939, the output was double this figure, supplying over 90 per cent. of the tinplate consumed in India. Correspondingly, there was a steady decline in imports, though in 1937-38, and 1938-39 the import figures showed a great increase. The following table shows the figures of production and imports from 1929 to 1939 :—

Indian Production and Imports of Tin plate

Year	Indian production (Tons)	Imports (Tons)	Total Indian consumption (Tons)
1929-30	35,681	31,087	66,768
1930-31	37,868	17,229	55,097
1931-32	38,306	7,584	45-890
1932-33	38,967	7,003	45,970
1933-34	45,270	7,240	52,510
1934-35	49,934	5,583	55,517
1935-36	51,839	6,488	58,327
1936-37	52,643	1,352	53,995
1937-38	53,431	7,441	60,872
1938-39	*46,761	14,013	60,774

Imports during the period came principally from the U. K. U. S. A., Italy, Germany and Japan; towards the end of the period, however, the share of Germany was negligible.

*Output in, 1938-39 was low owing to a strike.

In war-time

Uses.—Tinplate is essentially needed by all the three Defence Services. Mechanised armies depend on tinplate for their petrol, water, oil and grease, all of which must be packed in tins. It is also needed for packing food stuffs in operational areas, for army utensils like camp kettles, degchies, mess tins, water bottles, and gas mask boxes. In ammunition also tinplate is essential. Nearly every round fired or bomb dropped owes something to tin-plate. It is required for lining the boxes of rifles and machine gun ammunition. Charges for big guns are stored in tinplate containers. Fuses for small bombs and tails and vanes for bigger ones are all made from tinplate. Depth charges aso are dependent on tinplate.

Production.—These increased military demands have led to the expanlsion of the Indian tinplate industry and its output has risen by 40 per cent in the war time.

Production figures in war years are as follows:

1942	. .	58,300 tons
1943	. .	68.400 ,,
1944	. .	80,000 ,, (estimated)

The greatest increase has been in heavy gauge (26 B.G. and thicker) production in special qualities. This increase has been made possible by the fact that the finishing capacity of the Tinplate Company is greater than the rolling capacity, and the Company has therefore, been able to process and finish a larger quantity of heavy gauge material supplied in the form of sheet packs by Tatas. 3,680 employees in cluding clerks, town staff etc. are now working in the Tinplate Mills and their total wage bill comes to about Rs. 2¼ lakhs per month.

All this expansion has been carried out and maintained despite the loss of Malaya and its supplies of tin and palm oil Fortunately, however, the Company had fairly large stocks of tin. Some imports of English tin stocks of Malaya tin came from the U K. Recently there have also been imports of tin from China, though of inferior quality; when the shortage of tin was very acute arrangements were also made for the supply from Kenya of sufficient ore to yield about 35—40 tons of tin monthly, but these were given up when the supply position improved. By confining the use of tinplate to certain essential articles, such as containers for food-stuffs and pharmaceuticals, mess tins water bottle etc, the consumption of tin has been reduced by about 80 per cent. All other essential war demands requiring coated plate either for anti-corrosion protection or for ease of fabrication such as ammunition boxes and ordnance stores were produced in 'terneplate' (i.e, a coating of 75 per cent. lead and 25 per cent. tin). For civil uses uncoated steel sheets (Pickeld cold rolled and close annealed) are produced. These were found serviceable by the oil companies for civilian kerosene oil packing. For food packing it was found possible to lacquer and to lithograph the uncoated plate very successfully to produce an attractive and serviceable container for all commercial purposes. The Metal Box Company of India Ltd. in conjunction with local varnish manufacturers have carried out considerable successful experiment In this field. The Tinplate Company has also developed a suitable indigenous substitute for palm oil which is no longer obtainable.

The Company is in a position to produce any gauge, but usually the normal range fron 20 to 34 B.G. is sufficient for all except very special demands. The only qualities which the company does not make, are specialities known as 'Taggers' which are very thin plates less than 8-thousandths of an inch, and 'Tinned sheets' which are hand dipped. The size of the sheets can be anything below approximately 3 ft. by 2 ft. Sizes and gauges outside these ranges have been produced for urgent war need, like aircraft jettison tanks; but it has been at the cost of reduced production of other gauges. The Company now make some 216 different sizes and gauges of materials. The bulk of the production of the Company in war time continues to be in the sizes necessary for kerosene oil tins and for packing ghee, tea, butter, cigarettes etc. A rough analysis of the war-time demands on the Company shows that 40 per cent of the annual output goes for oil packing including civil kerosene oil packing,

25 per cent. for food packing, 15 per cent for Ordnance requirements and 20 per cent. for civilian uses.

Control.—Since 1941, all the production of the Tinplate Co. has been under the Iron and Steel Control instituted by Government. The estimated quarterly production of the Company is reported to the Master General of Ordnance in India, who in turn allots it to the various quota holders,such as the Director-General, Munitions Production, Engineer-in-Chief etc. These quota holders then issue licences for their requirements which are passed on to the Tinplate Company in the form of licensed orders by the Iron and Steel Control. The Control also arranges for the supply of raw materials, such as, tin bar and coal to the Company.

Post-war

After the war it is felt that a large number of the present demands will remain. It appears likely that the production of dehydrated and processed foods will continue and probably increase, in which case the demand for light gauge tinplate will also increase. India might also develop export markets in the East for this gauge of tinplate, particularly in areas like Singapore for the canning of pineapples ; it is also probable that the development of canning in India, which is receiving a fillip through war, will absorb the bulk of the output. If the produetion of terneplate continues along with that of tinplate after the war, provision will have to be made to prevent it from being used for making containers for food-stuffs, in view of its lead content. But the lion's share of the demand for tinplate will come as before the war and as at present from the oil companies for packing kerosene oil, and with the liberation of Burma and the resumption of the working of the oil wells there, greater demands will have to be met. Another possible export market in this connection is in the region round the Persian Gulf for packing oil. There is also great scope for increased demand for tinplate for packing vegetable oil, ghee etc, in India itself. It is also likely that the demand for heavy gauge materials would continue if firms owning heavy press tools continue in operation making cooking utensils, oil and paint drums etc.

(b) *Bolts, Nuts and Rivets*

Another important industry associated with steel production is the manufacture of bolts, nuts, rivets,washers, dogspikes and coach screws. These are all essential materials used for fastening structural and other engineering works. These articles are produced from the bars, rods and wires which come out of the main steel manufacturers. It is also a necessary ancillary to the engineering industry, because that industry depends on these articles being made by specialised producers. The manufacture of nuts, bolts and rivets is therefore a necessary intermediary between the steel industry ond the Engineering firms.

The importance of the industry will be clear also from the fact that the estimated production of these articles in India comes to nearly 30,000 tons, in the current year.

Before the war imports of bolts, nuts, rivets, washers etc. amounted to about 21,700 tons. (1936-37). (This included nails also). Guest, Keen Williams Ltd., Calcutta were then practically the only producers. Nuts and bolts were also made for their own use by the principal engineering firms and some railway workshops. The total production is not known, but it is certain that the requirements in India were largely met from imports.

War-time Developments

When war took a serious turn, imports fell away. But war had created a great demand for nuts and bolts another fastenings, because their need is naturally greater in structural work of the pre-fabrication and unit construction type. In ordinary civil buildings, the need for fastenings is not so great, but all military buildings, bridges, aeroplane hangars etc. have to be fabricated and carried in parts to the scene of war, to be adjusted according to requirements,

Especially in the conditions of the present war, the need for fastenings has turned out large. Apart from this, the very fact that steel consumption has nearly doubled indicates that the demands for nuts, bolts, etc., must have also increased, at least correspondingly.

The estimated consumption of nuts, bolts, etc, in India to-day is about 50,000 tons. Of this India, in spite of recent speeding up of production, supplies only about 30,000 tons. The following table shows the trend of increase in production :—

Year	Production in India (actual)
1942	12,589 tons
1943	19,654 ,,
1944 (estimated)	29,676 ,,

The remaining 20,000 tons come from the U. S. A. under lease-lend arrangements. Thus India is still largely dependent on imports. The Anglo-American Steel Mission (June 1943) regarded bolts, nuts etc. as a serious bottleneck in war conditions.

Guest, Keen, Williams Ltd., continue to be the principal producers of all fastenings in India. Their total production came to 11,000 tons in 1943. They are a branch of the well-known British manufacturers, Guest, Keen, Nettlefold Ltd. They obtain steel from Tatas and other local producers and from imports. This company has lately laid out a big extension to their works at Calcutta and have opened a workshop in Bombay.

Other producers have lately come into the field, namely Indian Wire products Ltd. (Tatanagar) and National Iron and Steel Works, Calcutta. But their production is small so far. Kaycee and Co., Lahore, have also taken up this line of production, and are trying to procure the necessary machinery with the help of Government.

Government have assisted to increase production by the following measures (1) procurement of necessary raw material for the manufacture of bolts, nuts, rivets etc. (2) supply of machinery: Some of the smaller machines are being made in India by machine tool manufacturers on whom orders are placed through the Machine Tool Controller. (3) supply of coal. and transport facilities to manufacturers.

Control, on an all-India basis, is exercised on the production of bolts, nuts, and rivets etc. as the demand is greater than the actual production.

Post-war Adjustments

After the war when ordinary modes of construction for civilian purposes are resumed it is likely that the total demands for bolts, nuts etc. will not be so great as in war time for the reason indicated above. All the same the normal demand is likely to be greater than in the pre-war period as some at least of the new industries started in war time will continue after the war. If no plan for post-war development is carried out, even the present production capacity may be found superfluous. It is, however, likely that house construction and bridge works for civil purposes will increase after the war, especially as such work have been put off in war time. And, therefore, it is probable that the present capacity will be required. If anything like a reconstruction plan is carried out after the war, even a larger capacity than the present may be required, and it may be possible to provide the extra steel within India itself Regarding the competitive capacity of the present industry there is not much ground for pessimism. For one thing, Guest, Keen, Williams Ltd. who are the principal producers of fastenings (as mentioned above) are associated with Messrs. Guest, Keen, Nettlefold who are the largest manufacturers of the article in the U. K. There is not much cause for doubt. therefore, regarding the competitive efficiency of this industry.

(c) *Steel Castings*

General and pre-war

Ferrous castings may either be of iron or steel. Whilst production of iron castings is relatively simple, the production of steel castings calls for specialised knowledge and a high degree of manufacturing skill. In order to permit the steel to run into the various moulds and forms which industry requires, it must first be brought to the liquid state. This is effected by means of electric or gas fired furnaces. The grade of steel may either be "acid" or "basic" depending on the type of hearth lining which the furnace possesses. When the lining is of silica sand, the steel is graded "acid", and when the lining is of dolomite the steel is graded "basic". Both grades are produced in the gas furnaces of India, but only basic grade is produced in the electric furnaces. When high speed cutting tool steels and other steel alloys of a like kind are required. the steel is prepared in specially designed electric high frequency furnaces which again are different from the electric furnaces employed for standard castings.

Steel castings production is a business quite apart from the usual iron and steel industry which produces rails for railways and sections suitable for building construction etc. The greatest demand for steel castings is from Railways, collieries, and cement. steel, sugar and jute mills. Railway castings, comprise chiefly axle boxes, buffer castings and plungers, bogie bolsters and drag boxes. Cement factories require a large number of special manganese steel castings as hard wearing jaws for stone crushers. Steel works and sugar mills need special pinnions and plates to withstand heavy wear and tear which on other material can withstand so well as steel. All underground coal drums must be shod with cast steel wheels.

The raw materials used in the manufacture of steel castings are many the following being the important ores :

Iron ore coal & coke, silica, dolomites, limestone, aluminium, fluorspar and manganese.

All these materials, in one form or another, are indigenous to India.

Smelting equipment comprise electric furnaces, transformers, electric cranes, gas producers, refractories, welding sets, sand blast equipment etc. Most of these are imported.

Before the war, the principal foundries specialising in steel castings production were the following :

Kumardhubi Engineering Works, Kumardhubi,

Hukumchand & Co. (now called Bharatiya Electric Steel Co.), Calcutta,
Burn & Co., Calcutta,
The B. B. & C. I. Railway Workshop at Ajmer.

The Combined annual production of the above firms was about 4,500 tons, before the war. This does not include castings made by Indian Ordnance Factories.

War-time.—The war gave a fillip to the industry by creating a demand for all kinds of castings which although formerly were imported had now to be produced in India owing to import restrictions. Not only were existing foundries fully extended but the use of substitute materials had to be resorted to until such time when several new foundries set up to meet the increased demand had acquired a certain amount of skill to produce consistently good steel castings. Most of the new foundries were set up by re-rollers and to-day the firms listed below in addition to those enumerated above, are registered under the Iron and Steel (Control of Distribution) Order, 1941 for the production of steel castings.—

National Iron and Steel Works, Calcutta, Steel and General Mills, Lahore, Mukund Iron and Steel Works, Lahore and Bombay, Indian Hume Pipe Co., Bombay, Singh Engineering Works, Cawnpore, J. K. Industries, Cawnpore, and the Mysore Iron and Steel Works, Bhadravati

One reason why the re-rolling mills have set up foundries was to avoid competition with the big Indian steel concerns, which specialise in rolling rails, sections, etc.

In this way the total production of steel castings in India rose to about 6,000 tons in 1942, and was about 8,000 tons in 1943.

The elimination of several bottlenecks, such as the lack of skilled labour, coal and transport problems, moulding sand problems, and lack of machining capacity, should permit the figure of 12,000 tons to be reached in 1945 and even this figure would, in no way, exhaust the capacity of India's furnace installations which are sufficient in themselves to provide about 30,000 tons of castings per year.

Some of the foundries have specialised in the production of ammunitions. The Kumardhubi Engineering Works deserve special mention in this respect. This firm carried out some pioneering efforts in the manufacture of trench mortar and aerial bombs. With the help of athes and other equipment designed at its own works, trench mortar bombs were manufactured on a mass production basis (at 35,000 bombs per month in 1943). This firm can take credit for the manufacture of aerial bombs also. Subsequently these lines of production were taken over by the Ordnance factory at Muradnagar, and the steel foundry output of the Kumardhubi Works is being used for new and maintenance parts of wagons and locomotives, manganese steel castings for cement works, castings for the coal trade, etc.

At the present time there is no price control to regulate the charges for steel castings, in consequence of which a number of foundries have been charging excessive prices for their products. This may stand in the way of these foundries expanding their production after the war. Hence the need for a careful price policy.

(d) *Wires and Wire Products*

Pre-war

The chief producer in this field before the war was the Indian Steel and Wire Products Ltd., Jamshedpur which began production on a small scale in 1928. At first imported wire rods were used for wire-drawing. But in 1932 the Company installed its own Rod Mill for the manufacture of wire rods. Since then the Company has been manufacturing all its products from raw materials obtained from Tatas in the form of billets. Until the outbreak of war, the Company was engaged in producing the following items for civilian needs :—

1. Rods below half inch in diameter.
2. Hard bright wire.
3. Annealed wire.
4. Galvanised wire.
5. Wire nails.
6. Barbed wire.
7. Bolts, nuts and rivets.

Some of these are not finished products, but only semi-finished articles like rods for wires, wire for nails etc. The last two items were being made only in very small quantities. The annual production of the above articles consumed approximately 50,000 tons of billets.

War-Time

After the introduction of the Iron and Steel Control, the Indian Steel and Wire Products Ltd., has been concentrating on the manufacture of articles for Defence purposes. This meant production of new kinds of wires. Other firms have entered the field, but all of them are small concerns. The present Indian production covers the following list of articles :—

(1) M.S. rounds and squares below half inch in diameter untested and tested (to different specifications) generally used in re-inforcing.

(2) In addition to the varieties of wires mentioned above, produced before the war by the Indian Steel and Wire Products Ltd., the following varities are also now being made in India :—

(i) Barbed wire.
(ii) Telegraph and Telephone wire.
(iii) Signal Wire.
(iv) Bead wires (for tyres).
(v) High tensile wire.
(vi) Spring steel wire.
(vii) Strand wire.

These wires are required for many uses civil and military.

(3) Wire nails, 1 to 10" in length (in all 85 combinations of lengths and gauges) including panel pins, gimp pins, slating nails, roofing nails, shoe nails; dowel nails etc., are also produced in India. These types of nails are widely used in the manufacture of packing cases, in shoe trade etc.

Some of the wires. e. g., the telegraph wires and barbed wires, were originally considered to be beyond the scope of the Indian Steel and Wire Products Ltd. But soon after the outbreak of war, the Company took up these lines of production and was successful in developing telegraph wires to the required specifications and the Government needs for this material were fully met. Similarly the production of barbed wire which was negligible before the war increased sufficiently to supply as much as 500 to 600 tons a month for Defence demands. For this purpose the Indian Steel and Wire Products Ltd. has had to extend its plant by the purchase of 24 additional barb machines during the period. Consequent on the expansion of manufacturing facilities in the barbed wire and galvanising departments, the Company has had to instal new machinery for the drawing of wire, involving an outlay of several lakhs of rupees.

The present production capacity of Indian Steel and Wire Products Ltd. is as follows:—

	In tons per month
1. Bars and wire rods	5,000
2. Hard bright and annealed wire	3,600
3. Galvanised and Telegraph wire	600
4. Barbed wire	500
5. Wire nails	1,200
6. Bolts, nuts and rivets	75

But the above capacity is not worked to the full owing to the reduced supply of billets. The pre-war consumption of 50,000 tons of billets annually was reduced to 48,000 tons since the Steel Control came into operation. From February 1944 the allotment has been further reduced to 36,000 tons of billets. From January 1944 there has been no demand for barbed wire and this has led to the closing down of the barbed wire plant. For wire nails to the demand has fallen largely and it is now far below the production capacity of the Company.

Other Producers:—(1) National Screw and Wire Products Ltd., Calcutta, was recently started and is the only properly organised form among the smaller producers. Its factory is situated at Belur. The details of its production are as follows:—

Products	Sizes manufactured	Capacity (per month)
Wire	16 gauge and thicker annealed and Hard bright untested.	100/150 tons.
Nails	1" to 6"	70 tons.

(2) Indian Hume Pipe Company has a wire drawing plant, the products of which are utilised in the manufacture of Hume pipes.

Apart from these two, there are some other smaller firms engaged in the manufacture of wire and nails. They are not properly organised. They have

only second hand machines, and hence are not very efficient and other cost of production is very high. Their names, products and production capacity are given below :—

Small producers of wire and nails

Name of Firms	Products	Approximate monthly Capacity (in tons)
Wire		
1. Calcutta Wire Nails Co. Ltd., Calcutta.	Wire, annealed and Hard bright 8 to 16 *g*.	140
2. W. Leslie and Co., Jaipur ..	2 to 12 *g*. Wire	98
3. W. Leslie and Co., Aligarh ..	Do	45
4. Benares Steel Rolling Mills, Benares Cantt.	10, 12 and 14 *g*. annealed and hard Bright.	7½
5. Liloonh Steel and Wire Co.,	Do	39
6. Bharatia Steel and Engineering Co., Ltd., Calcutta,	Do	12
7 Wire Nail Ltd., Bombay .	10. 12 and 14 *g* wire . . .	78
8. Hyderabad Wire Products Co, Hyderabad.	10 12 and 14 *g* annealed and hard bright wire.	156
9. Hindustan Wire Products Co., Benaras.	Wire 14 *g* and thicker . .	50
10 Chaliha Rooling Mills, Wire Tollygunge.	..	Not known.
Wire Nails		
11. Padam Engineering Works, Bombay.	Wire nails	9
12. Wire Nail Mfg. Co., Bombay	Wire nails 3/4" to 4" . . .	26
13. India Metal Products Bombay	Wire nails ½" to 8" . . .	35
14. Lusob Trading Co., Bombay	Wire nails	Not known.
15 Karfules Ltd . Bombay .	Do	Not known.
16. Bharat Wire Netting and Metal Products, Karachi.	Wire nails ½" to 1" . . .	1½
17. Wire Nails Ltd Bombay . .	Wire Nails	4
18. National Insulated Cable Co, of India Ltd. Calcutta (Works at Mehgaon, C.P.).	Nails	20
19. Kushiran Tarachand, Karachi	Nails	20
20 Small Industries, Manapuram, Trichinopoly.	Nails	10

The actual working capacity of the above firms would be far below this tonnage.

In some areas, nail making has been taken up on the cottage industry basis five such units are working in a small town in Cochin State (Kunnankulam), one of these being an Industrial Institute for Defectives !

The figures of Indian Production and Imports are given below :—

	Indian Production	Imports
Wire (Barbed)		
Telegraph and Miscellaneous		
1943	15,100 tons	27,200 tons.
1944 (Estimated)	17,800 tons	16,000 tons.
Wire Nails		
1943	11,600 tons	11,200 tons.
1944 (Estimated)	14,000 tons	12,700 tons.

Only those producers whose capacity is utilised to meet Government and licensed demands are getting assistance in the form of the supply of raw materials, transport facilities etc. At present only the Indian Steel and Wire Products Ltd., are getting such help, and even they are complaining that they are not getting raw materials in sufficient quantities to engage their production

capacity in full. The fall in the supply of billets in part of the general reduction in iron and steel output caused by the shortage of coal and the difficulties of transport. The steel Control authorities plan the output of each factory according to M. G. O.'s requirements in order to make the best use of the coal and transport facilities available.

POST-WAR

In the matter of quality, the products of Indian Steel and Wire Products Ltd., can now claim to be on a par with the imports. The other producers except the National Screw and Wire Products and the Indian Hume Pipe Co. are small concerns. After the war, unrestricted imports from foreign countries, especially from America, which has made vast provision for additional industrial equipment, may hit internal production. The question of counter acting this calls for a careful examination of the problem.

Again if all these firms are to continue in the field, there is the danger of over-production also. This may affect the position of even the main producers. Hence the necessity for some form of rationalisation in the industry. Extension and consolidation of the Industry and the manufacture of new wire products would require plant and technical experts from abroad and Government help would be necessary for this. The greatest problem after the war would be supply of raw material, chiefly steel. The agreement between Tatas and the Indian Steel and Wire Products Ltd. expired in 1941. After the war a proper agreement will have to be made between the steel industry and the wire and nail industry.

SECTION II.—NON-FERROUS METAL INDUSTRIES

1. General

India is highly deficient in regard to the essential non-ferrous metals. Aluminium, copper, lead, zinc and tin have important industrial uses, and are essential for Defence purpose. We have ample supplies of bauxite for making aluminium, but production has only just started. (See next section). India's copper supplies are meagre, and her present supply of about 6,000 tons per annum is hardly a tenth of her requirements. Even this is not refined electrolytically and therefore is not suitable for many important purposes. We have no tin and our local deposits of antimony, lead and zinc are even more meagre. India is therefore almost entirely dependent on imports for her needs, and for the rest must count on the recovery of scrap.

Rather serious was therefore the position that faced the Government at the outbreak of the war. The first concern was to economise in the use of every non-ferrous metal available and this involved the setting up of a stringent control, which in the nature of the case had to be in co-ordination with similar control, set up by the Allied Nations. Taking the United Nations as a whole, the supply of non-ferrous metals was found far short of requirements, and therefore the U.K. and the U.S A. had to take drastic steps for economising in their use and for securing the greatest possible recovery from scrap. Their use for prohibited except where no easier substitute was available. India, depended on imports from Allied Nations for a good part of its non-ferrous metals, had in fairness to accept the same tests of essentiality as are applied in the countries of supply. The paucity of available shipping space also made this policy imperative.

Thanks to the organization known as the Combined Raw Materials Board set up by the United Nations and the careful study carried out by that Board in regard to the statistical position of each of the critical raw materials, it was possible to allocate the available supply for essential needs. It is thus that the copper supplies from Belgian Congo came to India and the tin purchased by U.S.A. from China was shipped to India to meet our needs here. It may be pointed out here that India's imports were obtained through the Non-Ferrous Metals Control established in the U.K. All the involved the setting up of a control analogous to that set up in the U.K.

While the need for strict control was thus quite clear there were special difficulties to be overcome in carrying out an effective control. "The Metal business before the war did not pass through well-defined channels and consumption except by Government departments was relatively small. There is therefore a complete absence of a statistical background on which to work. Further there was no highly organised scrap utilisation trade, no scientific sorting, no laboratory control and no standard specification" Most scrap found its way to the bazaar where it was mixed up with other scrap and lost all claim to pedigree. Lately efforts have been made by the Disposals Branch (Metals Directorate, D.G.M.P.) to use in the most economical way all the scrap coming under Government, e Railway and Ordnance Factories.

Production of Non-Ferrous Metals.—The increased war demand for non-ferrous metals and for the manufactures thereof gave a fillip to their production in the country, and this has had notable influence on the mining of ore and on the refining of scrap. Great impetus was also given to the manufacture of the various alloys required for conversion into sheets, pipes, tubes, etc., required in Electrical, Automobile, Shipbuilding, Aircraft and other industries.

As in the case of the Iron and Steel Industry the production of the metal may be primary or secondary. Primary production of Non-Ferrous Metal is from ore, while the refining of scrap may be considered secondary production. To the latter category also belongs the extraction of any individual metal or alloys from mixed scrap and residues which are the by-products of industry.

Primary Production.—(1) *Copper.*—In India the smelting of copper ore has been carried on at the works of the Indian Copper Corporation at Ghatsila. Their product, however, is inferior to the product of the larger refineries in Africa and U.S.A. in that they have no electrolytic refining plant. They produce what is termed fire-refined copper and they are unable to exclude a small proportion of nickel which precludes its use in the wire drawing and electrical industries. Thus India is required to import all her electrolytic copper. The cost of smelting and refining in India is high and therefore our copper cannot stand competition with the cheaper imports from North Rhodesia (Africa) and the U.S.A. The Indian Copper Corporation, however, manufacture brass sheets and are able to hold their own against imports, because they are able to produce brass sheets from their own copper. The price of imported zinc is lower than the landed cost of brass sheets from abroad (this difference is probably due to the higher freight charged on the more carefully packed brass sheets).

(2) *Antimony.*—There are small deposits of antimony in Chitral and Lahaul (Spiti), but owing to the lack of transport facilities and the resulting high cost there had been no incentive to work these mines except in times of stress When imports ceased under the stress of war, the price of the metal rose and this encouraged the working of the mine. Steps in this direction were taken and the ore has been brought from Chitral by a Bombay firm, the Star Metal Refinery, which has a smelter producing about 220 tons of antimony per year The company has received no assistance from the Government but has been sustained by the high prices ruling in the market. As the mine is in accessible during the winter months and even during summer months, the ore has to be carried over the mountain pass by mule or man, and therefore the cost of the ore on arriving at the smelter is extremely high; nor are the methods of extraction very efficient. It is therefore doubtful if this industry will be able to cope with the post-war troubles which are bound to ensue when cheap imports from China and the U.K. become available. Better transport facilities for bringing the ore from Chitral and the modernization of the production process may cut down costs, but it is doubtful if the deposits in Chitral are large enough to justify the opening of communications and laying down of a plant at a high cost. This is for further study and examination.

Antimony is used mainly in the preparation of white metal and printing alloys. About 70 tons per year is used by the Ordnance factories. Most of the printing metal in use in India is revived old metal, because whether for printing or for antifriction purposes the metal can be used over and over again,

with small quantities of virgin metal added to 'revive' or in other words make up for the oxidisation losses which occur during the melting process. Therefore the use of virgin antimony is small. Antimony Sulphide is used in the match industry.

(3) *Lead.*—Although Lead was not in as short supply as the other metals, developments in the Far East necessitated the tightening up of the control. Further, the consumption of Lead has increased owing to the degrading of white metals and solders, and owing to its use as a substitute for aluminium in the lining tea chests. Imports of lead which came to only 11,500 tons in 1939-40 rose to 21,000 tons in 1942-43.

A small lead smelter has lately been 'blown-in', in Bihar, by the Eastern Smelting Co., Calcutta. This smelter has had some initial difficulties but it is believed that these can be overcome and the smelter can be made a success, provided ore is forthcoming. The paucity of ore supplies is a serious problem facing the Company. Lead deposits are to be found in various parts of India and the Geological Survey of India has developed one or two deposits but it is generally held that no economically workable lead deposits have so far been discovered in India. The lead-zinc deposits of Zawar in Mewar State (Rajputana) are under investigation. There are also deposits in Jaipur State which may repay development. With the return of peace and the resumption of mining operations in Burma coupled with the large Australian production, there is some doubt regarding the post-war position of the lead-smelting industry. At any rate it is felt that a small smelter like the present may find in difficult to compete successfully. Whether any larger venture is worth while has also to be investigated, but this depends on the development of India's lead deposits.

(4) *Tin.*—Tin is essential for the manufacture of antifriction metals and solders. It is also needed for the tinning of vessels for domestic use, and for the manufacture of tin foil which in peace time was used for wrapping eatables. It is also used for the condenser manufacture in the Electrical Industry. No economically workable deposits of tin have so far been discovered in India and this country had been drawing its supplies from Malaya and Burma. With the loss of those two countries the supply position became serious, and tin was then included in the Non-Ferrous Control Order. The position was aggravated by the non-co-operation on the part of dealers who removed stock to Indian States or otherwise concealed it. Tin at the disposal of the Government and in the hands of the co-operating firms was strictly rationed during 1942, thus alleviating the position. Before Japan entered the war, Indian consumption came to about 2,500 tons per annum. By strict control India's consumption was reduced to about 1,600 tons in 1943.

Under these influences Tin smelting was attempted in a small way, by the H. G. Refinery, Konnagar. It was put into operation for smelting Burma ore but after Japan's entry into the war it has been dealing with residues of Indian origin. Indications at present, however, are that this will not develop as a postwar proposition especially as there is no indigenous ore and as competition will be serious when Malayan smelters resume production.

Refining of Non-Ferrous Scrap.—In countries where there is a paucity of virgin, metal every effort has to be made to refine the scrap. In Germany during World War I the process of refining scrap was brought to a high state of perfection. For example as there is no tin available in Germany, successful attempts were made to recover tin from tin-plate scraps of all kinds, by using an electrolytic process. Similarly, scrap brass so inferior in grade can be used to produce Zinc Oxide for paint manufacture and the residual impure copper can be refined electrolytically to produce high grade copper for all purposes.

India has not given sufficient attention to this important problem and scrap available in the country before the war was shipped to Japan, Germany and other countries at nominal prices to be reimported in a refined condition at high prices.

In India, the recovery of Yellow Metal scrap is an old industry and large quantities of debased scrap of unknown quality were consumed in the making of domestic utensils and the cheaper ornaments and trinkets, but very little had been done in the field of White Metal recovery. (The term White Metal refers to alloys of tin, lead, antimony and copper. 'White Metal' is also called Antifriction metal, and bearing metal—all these mean the same thing in metallurgical parlance. 'Yellow Metal'—covers the brass and bronze group which are alloys of copper, zinc and tin, with varying quantities of lead, depending on the purpose for which the metal is required). Lately several firm have started while metal refining, side by side with yellow metal refinings India Standard Metal Works, Bombay, is one of them. They refine non-ferrous scrap of all kinds and with it make gun metal ingots, phosphor-bronze ingots, white metal etc. It is believed that they are technically competent to compete with the old established firms and importers. Post-war competition would no doubt be fierce, but the Industry as a whole should be able to stand on its own feet, provided an adequate quantity of raw materials can be obtained. If only this country would become scrap-conscious and conserve the scrap which hitherto was shipped out or thrown away, a prosperous Refining Industry can be built up after the war, especially as various semi manufactures non-ferrous metals will be required in all lines of industrial development.

Non-Ferrous Metal Manufactures.—During the war India has made great strides in the production and processing of non-ferrous metal alloys and could have made still greater progress had it been possible to import modern plant with trained personnel. The greatest development has been in the production of wire, strip and rod, a field which has hardly been touched before World War II. During the first three years of the war, demands for processed metals were very heavy and firms were encouraged to expand and take on this new type of work. Many concerns came forward at a very critical period and laid down plant and equipment—such plant and equipment as could be made in India—and rendered valuable service. Only the salient features of this development will be considered below.

(1) *Brass and Copper Wire.*—Brass and electrolytic copper wires have innumerable uses in electrical engineering. This will be dealt with in the Section on Electrical Engineering.

Ordinary brass and copper wire is also used in jari manufacture (for ornamental clothing), in making rivets, copper tacks (for boat building) screw wire and nails (footwear industry), and also for packing binding and many other purposes. Large quantities of wire are being made for these purposes. A certain quantity of phosphor-bronze wire is also being made. But only wire of small coils of about 7 pounds in weight has been so far produced whereas imported wire may be in coils of up to 100 pounds. in weight. The advantage of heavy coils is obvious when the wire is to be consumed in automatic machines. Generally speaking Indian brass and copper wires come up to a reasonable standard, though lacking perfection in accuracy of gauge and temper. It is hoped, however, that the quality will improve still further in course of time.

The principal producers of brass and copper wires are the following;—

(a) The Kamani Metal Refinery and Metal Industries, Jaipur.
(b) The India Rolling Mills Ltd., Calcutta.
(c) The Jayant Metal Manufacturing Co., Ltd., Bombay.
(d) The Bharat Cable and Rubber Works, Delhi.
(e) The National Chrome Plating Co., Aligarh.
(f) The Indian implements Manufacturing Co., Aligarh.
(g) The National Screw and Wire Products Ltd. Calcutta.
(h) The Surat Jari Industry, Surat.

The price of wire produced in India at present is two to three times that of imported wire, but to a large extent this is due to the high price of the metal used to make the wire. The use of imported modern continuous wire

drawing, equipment is necessary, to bring down the cost of production. Diamond wire drawing dies to cover the smaller gauges may also be useful. Wire drawers must realise that the tool room is the heart of their plant, and should be equipped accordingly. Annealing equipment will have to be given more attention after the war; electric muffle furnaces will no doubt find their place in the industry, but improved designs of coke, coal, gas or oil fired furnaces will probably follow as an added improvement, but should not cause any more concern to the industry in the immediate post-war period.

(2) *Sheet and Strip* (*Brass and Copper*). The Indian Copper Corporation Ltd., Ghatsila, are the largest producers of hot-rolled sheets in India. These sheets are of as good a quality as imported sheet, and they are even cheaper. It is not considered that the Corporation will need any assistance after the war; in fact, they are only waiting to recapture their lost markets. But, they only roll sheets down to 21 SWG approximately. Before the war sheets finer than this gauge were imported as there was no reliable cold-rolling capacity available.

When war broke out and the importation of linings for tea chests from U. K. was found difficult, the Venesta Lead Mills Ltd., Kamarhati, started production of tea lead for the lining of tea chests. This was possible because of the availability of raw material in the form of Burma lead. But with the loss of Burma, the supply of raw materials stopped and the firm had to give up production of this item. This however, enabled them to place at the disposal of the Government two of their precision mills, and this has solved in part India's shortage of fine gauge of close tolerance rolling capacity. With the help of their first class equipment, including Nickel Chrome Steel Rolls with a modern grinding lathe, they have done admirable work in cold-rolling brass and copper sheets to gauges as low as 30 SWG. This is the only firm capable of carrying out precision cold-rolling, but this capacity will probably be lost after the war if the firm reverts, to their normal industry of producing tea-lead although competition from the aluminium industry may affect them.

Yellow metal sheets are consumed in large quantities in India for the manufacture of utensils. Brass sheets are also used for stores, sterilisers, etc. Therefore there is a large demand for brass sheets and this has to be met. The following firms have been carrying out certain amount of cold rolling in the thinner gauges but owing to lack of equipment they have not been able to produce sheets in fine tolerances.

(1) The Kamani Metal Refinery and Metal Industries, Jaipur.
(2) The India Rolling Mills, Ltd., Calcutta.
(3) Lalubai Amichand, Bombay.

In the circumstances mentioned above; it is generally held that one or more of these firms should be allowed to import a rolling mill with steel rolls together with a roll-grinder, in order that supplies of cold rolled strip may be available in India in increasing quantities.

(3) *Rods and Bars* (*brass and copper*) —During the war India has become almost self supporting in her requirements of round brass rods and bars, which have been produced by hot rolling billets, in sizes ranging between 1/2" and 3" diameter. It is almost certain that these bars would not be accepted by consumers after the war, as they vary from the nominal diameter by + 1/32" maximum, to—Nil, and have a relatively poor surface; the physical properties also are not exceptionally good. As regards the war period, such hot rolled brass bars have done the job, which is the main thing, but it is a great disadvantage that the machining properties are not too good. Consumers will insist on extruded specification bars and rods after the war, and therefore to keep this industry going, the importation of an extrusion press, complete with auxiliary equipment may have to be allowed. Several firms have come forward in the past three years requesting permission to import an extrusion press,

but as a war time measure this could not be allowed, especially as the rolled brass bars are meeting all demands at present. The following firms have supplied the bulk of hot rolled bar:—

(a) The Steel and General Mills Co., Ltd., Moghalpura.
(b) The Kamani Metal Refinery & Metal Industries Ltd., Jaipur.

Brass and copper bars below 1/2" dia. have been produced by cold-drawing at the following main firms:—

(a) The India Rolling Mills Ltd., Calcutta.
(b) The Lillooah Steel and Wire Co. Ltd., Bombay.
(c) The Jayant Metal Manufacturing Co., Ltd., Bombay.

The prices which have been paid for hot rolled bar have been reasonable as Government has supplied the billets and paid the firms for conversion only. On the other hand the prices paid for cold drawn bar have been high, and would not stand a chance against the prices of imported bar after the war. However, if a modern extrusion press is laid down at one of these firms there is no reason why the price should not be as cheap as that of imported bar. It is not considered that the demand for brass and copper bar would merit the importation of more than one extrusion press. India has only been able to produce hexagon, square and rectangular sections with difficulty and at great expense, but with an extrusion press could easily compete with imports.

(4) *Lead pipes.*—Lead pipes are mainly used for (1) household water fittings and (2) for the construction of chemical plants.

Lead pipes were formerly being imported; in 1940-41 imports amounted to 11,700 tons. The imports, however, gradually diminished when local production increased and in 1942-43 imports came to only 3,000 tons. Lead pipes are now being manufactured in India by D. Waldie & Co., Ltd., Calcutta, in sizes ranging from 3/8" to 6" internal diameter. This firm is able to meet the Indian demands in full on a war time basis, because of the restrictions in the use of the materials. After the war when these restrictions are removed, its production capacity may probably be found insufficient for India's total requirements.

(5) *Lead Sheet.*—This is used chiefly in building construction, chemical industry and tea industry. India has so far been producing only lead sheets up to 3' wide. But the usual demand is for greater widths up to 8'. Therefore if this Industry is to serve Indian requirements a mill will have to be set up for producing sheets of larger with. The principal firms now producing lead sheets are—

(a) The India Rolling Mills, Ltd., Calcutta.
(b) The Venesta Ltd., Kamarhatti.
(c) M. Gulamali Abdul Hussain & Co., Bombay.

(6) *Belaring Metals, Gun Metals, Phosphor-bronze, etc.*—India has produced large quantities of these metals in ingot form during the war, and has now reached fairly high standard of production. It is considered that the markets can be held after the war with but little additional assistance to the manufacturing firms. At present prices are high compared with imports, but this is largely due to the high prices which the firms have to pay for the basic metals, which may not be the case after the war. The chief producers of these metals are the following:—

(a) The Indian Smelting & Refining Co., Ltd., Bombay.
(b) The Indian Standard Metal Co., Ltd., Bombay.
(c) The Binani Metal Works Ltd., Calcutta.
(d) Messrs. Gerhard Gabriel, Bombay.
(e) The Bengal Ingot Co., Ltd. Calcutta.
(f) The Kamani Metal refinery & Metal Industries, Jaipur.
(g) The Eyre Smelting Co., Calcutta.

(7) *Tubes (Brass and Copper).*—Up-to-date little progress has been made in India in the manufacture of seamless tubes. A few concerns are now

making feeble efforts to produce tubes by crude methods, but it is not proposed to discuss the production of such firms here. Messrs. Madhoram Mool Chand, Karachi, have been pioneers in producing copper tubes in sizes up to 1/2" o/d by rolling over a mandrel, but their price is very high and their capicity is limited with their present methods of production, they will not be able to compete with imported tubes after the war. Full details and drawings of a scheme to produce solid drawn tubes by the cored shell method have been circulated to the following interested concerns:—

(a) The Indian Standard Metal Co., Ltd., Bombay.
(b) The Kamani Metal Refinery & Metal Industries, Jaipur.
(c) Modhoram Moolchand, Karachi.
(d) The National Rolling Works Ltd. Calcutta.
(e) The Binani Metal Works, Calcutta.

None of these firms have gone very far with the scheme, although most of the plant could be produced in India. It is thought that the Indian Standard Metal Co., Ltd., are likely to be the first to go ahead with manufacture by this method, and they are endeavouring to import a heavy breaking down bench from the United Kingdom. With the necessary initiative there is no need why any of these firms could not go ahead with tube manufacture. There is an idea that tubes can only be produced satisfactorily by the extrusion method, and therefore several firms are keen to import an extrusion press for this purpose. This might be considered as a post-war measure, but it is not considered essential, as even to-day large tonnages of brass and copper tubes are produced in the United Kingdom and the U.S.A. by the cored shell method. An extrusion press would involve a very big capital outley, and extruded tubes invariably have to receive a sizing operation on a drawbench after extruding. It is therefore considered that every encouragement should be given to the firms after the war to produce tubes by the cored shell method.

(8) *Plumbago Crucibles.*—These are required for melting yellow metals and are especially needed in mints. During the war the manufacture of plumbago crucibles for metal melting has made great strides in India. The principal firms engaged on crucibe manufacture are detailed below:—

(a) The Himalaya Potteries Ltd., Balawali, E.I.R.
(b) The Patna State Graphite Co., Ltd., Titilagarh. B.N.Ry.
(c) Jhaveri & Co,, Ltd., Calcutta.
(d) The Indian Crucible Works, Rajahmundry.
(e) Alladin Virjee Nathani & Co., Ltd., Darukhana, Bombay.

So far only the smaller sizes of crucibles have been manufactured. Results up to date have not been comparable with imported brands of crucibles, as the firms have been using Indian graphite, which is of a varied composition and structure. Crucible mixtures require graphite flake rather than powder, and the carbon content of Indian graphite is far below the desired figure of 90 to 93 per cent. Ceylon graphite is suitable for this purpose having 93 per cent carbon content and a flake structure. Provided that facilities can be given to these manufacturers to continue to import Ceylon graphite there is no reason why this industry should not flourish after the war.

(9) *Electroplating.*—The electro-deposition of metals has made good progress during the war particularly of copper, nickel, tin, cadmium, chrome, and zinc. Hard chrome plating of steel components was introduced and has been most successful. Anodising of aluminium and its alloys is being undertaken both as a decorative measure and as a means of corrosion prevention. India is now in a position to produce some of the ingredients which are necessary to carry out these operations such as copper salts, chromic acid, tin anodes, copper anodes, antimonial lead anodes, etc. Given facilities to import the ingredients after the war, which cannot be produced in India, there is no reason why this industry should not continue. The main suppliers of ingredients in the United Kingdom, such as W. Canning & Co , Ltd., Birmingham, frequently send out one of their technical representatives in peace time to assist electroplaters, and this should again be encouraged after the war.

General.—The specific cases dealt with above do not cover the full range of India's non-ferrous industry to-day; but it may serve to give some idea of the recent expansion of this industry and its post-war possibilities. Many sections of the industry owe their origin to the restriction of imports. If after the war these restrictions are removed, the new industries will come under the full blast of foreign competition and some of them may wither away. Even to-day if shipping space allows of importation the same results may follow. Therefore it is necessary to make various decisions in regard to the future of these industries. Should the industries which could not stand on their own legs be supported by protective tariff or by other devices? Decisions on this question can only be arrived after a careful consideration of many factors which cannot even be touched upon here.

A few generalizations may, however, be made in regard to the urgent need of joint action among industries for securing common interests and for improving the technique of production.

Firms in the United Kingdom are bound together into powerful bodies such as the Cold Rolled Brass and Copper Strip Association, the Brass Wire Association etc. Not only to these associations safegaurd the industry as a whole, but also fix selling prices, which are honoured by all firms who are members of the Association. There are no similar bodies functioning in India, but there is even greater need here for such associations. Firms must not think in terms of big profits after the war if they want to hold the Indian markets: a competitive selling price, fixed by the association, will have to be the practice.

Apart from the types of associations referred to above, there are technical bodies in the United Kingdom, sponsord by the trade, who publish technical literature and assist manufacturing firms in their metallurgical problems. Two such associations are the Copper Development Association and the Zinc Development Association; but there are many others. It would also be most desirable to have similar bodies in India functioning after the war. These associations must tackle India's peculiar metallurgical problems, metal melting under monsoon conditions, processing by not too modern methods, etc. Manufactures in India have been somewhat secretive in regard to processes, but if India is to make a real advance in the industry this attitude must change.

During the war period one of the greatest handicaps has been the lack of trained metallurgical personnel. Some of the Universities give a sound theoritical training, but there they appear to stop. It is the practical man who makes the metal, and it is the practical metallurgist that India needs. The University courses in technology must keep in close touch with industries. Students must be made to spend some time observing work in such firms as the Indian Copper Corporation Ltd., Ghatsila, or the Metal and Steel Factory, Ishapore. Firms should welcome and encourage such visits; thereby they will be able to recruit trained workers.

A research body in India on the lines of the British Non-Ferrous Metal Research Association, would be a great advantage but it is understood that the Council of Scientific and Industrial Research, India has this problem already in hand.

All the metal producers have not the facilities at their own works to carry out the physical and chemical tests demanded by certain specifications. There is really no need for them to have such facilities if they follow a practice which is common in the United Kingdom : about twenty firms there get together and form a guild, such as the Midland Laboratory Guild, Birmingham, and lay down a complete laboratory with a test house. A competent metallurgist is put in charge of the Guild, and all the tests are carried out at actual cost. Such a scheme would be a great advantage to manufacturers during the post-war period.

The Non-Ferrous Metal Industry in India is in its infancy and this country has a long way to go if she is to take her proper place among the non-ferrous producers of the world. Especially in view of her paucity of raw-material, active

steps are called for. Without a much higher level of technical knowledge than now obtaining in India, competition with the outside world is out of question. In these circumstances there is urgent need for concerted effort. If India uses her opportunities well and gets astride in time, not only will she be able to supply her own expanding markets but may also capture a portion of the Eastern markets.

2. Aluminium

General.—Aluminium has come into great prominence in war-time industry owing to the large part it plays in the aircraft, automobile, chemical and other industries. From 5 to 15 tons of aluminium is required in the manufacture of an æroplane according to the kind and capacity of the plane. Bodies and other component parts of automobiles are now being increasingly made of aluminium alloys. Owing to its lightness and comparative cheapness, alluminium is required in a variety of other industries, electrical, chemical, metallurgical, etc. Aluminium is preferred for the blades of fans, containers for certain oils, medicines, soaps, etc. It is also used for de-oxidising steel. In America, the use of aluminium ranges from elegant architectural purposes to the making of common articles like window frames.

In India, however, the largest use of aluminium so far has been making domestic utensils. Before the war, 90 per cent. of the aluminium supplies in India went to make cooking utensils, whilst only 12 per cent. was so used in North America, where its use is predominantly in the field of transportation (60 per cent.). In India, too, as a result of the war, aluminium has entered into the field of transportation, and increasing quantities of the metal are being used in our embryo aircraft and automobile industries.

As in the case of steel, there are 3 distinct stages in the manufacture of aluminium goods. The first is the production of the metal from the ore (bauxite); the second is the fabrication from the metal of sheets, structural shapes or bars, castings etc., the third is the manufacture of consumer goods, such as containers, domestic utensils, etc. In India, as in other countries, the various stages were taken up in the inverse order, the third stage coming first and the first coming last.

Before the war

The importance of the aluminium industry was realised in India early in the present century. In Madras, under the inspiration of Mr. (later Sir Alfred) Chatterton, then Director of Industries, an aluminium factory was started in 1912 by the Indian Aluminium Company, Ltd. This factory, however, was only engaged in the third stage of production, i.e., it converted into saleable articles the sheets or circles imported from outside. After 1918, labour troubles developed in the industry and the affairs of the company went from bad to worse until it was liquidated in 1939.

In 1918, the well-known firm of Jeewanlal & Co., came into being. Jeewanlals established their chief factory at Calcutta, with branches in many centres, including even places outside India, Rangoon and Aden. After the last war, the price of aluminium fell and aluminium maufacturers in other countries made a bid for the Indian market. One of these competitors was a Canadian Company, and Jeewanlals were merged with this company in 1929. Thus came into being "Jeewanlal (1929) Ltd." This company purchased the Indian Aluminium Company, Ltd., Madras, when it was liquidated in in 1939.

In the meantime, several other concerns also had come into the field. The most important of them are :—

(1) Aluminium Manufacturing Co., Ltd., Calcutta.
(2) Wolverhampton Works Co., Ltd., Bombay.
(3) Anant Shivaji Desai, Bombay.
(4) Lallubhai Amichand, Bombay.

Of the companies functioning before the war, Jeewanlal (1929) Ltd., was the biggest, ond it specialised in the manufacture of domestic utensils. It had also extensive trade connections with Malaya, Burma, East Africa, Aden, etc. The Aluminium Manufacturing Co., and Wolverhampton Works, tried to

develop industrial uses for aluminium, i.e., articles and equipment for tea and rubber estates and factories ; bobbins for jute mill manufacturers, castings for electrical and engineering work, and equipment for paint and chemical industries.

In war-time

With the outbreak of war, imports of aluminium sheets and circles diminished and finally ceased in 1940. Thus secondary aluminium scrap became the only source of supply for all essential requirements. For one reason or other aluminium was replacing brass and tin for various uses. Especially after the loss of tin supplies from Malaya, the importance of aluminium greatly increased. In these circumstances Government was compelled to introduce strict control over all available scarp and it was decided to release aluminium for essential purpose only, viz., (1) auxiliary parts of electrical transformers, (2) scientific instruments, (3) certain service utensils. (4) field telephone parts, (5) aircraft production, (6) post and telegraph requirements, (7) medicinal containers and (8) air raid sirens. Release of aluminium was refused for the manufacture of such articles as utensils for civil purposes, ornamental, wares, bodies of motor cars. table ware and furniture.

In view of the scarcity of the aluminium active steps ware taken by some of the aluminium companies to collect all the scrap available. They worked through their branches and used their canvassers also for this purpose. In this way they have collected altogether a large quantity of scrap aluminium. They also installed furnaces for melting and refining the scrap, and with the help of small rolling mills, ingots were rolled into sheets for her manufacture of articles like cooking utensils, electrical fan plates, aircraft fittings, containers, etc. In this way; these companies have become self-contained as aluminium utensil producers. In particular, Jeewanlal (1929), Ltd., have expended their business in war time. Their organisation for collecting scrap is widespread and it is believed that their collections are large.

In war-time, the principal lines of production of the aluminum companies are:—

(1) Jettison tanks (to be carried by aeroplanes).
(2) Fuse pads used for gun firing.
(3) Casting for distilleries.
(4) Percolations for the fruit juice industry.
(5) Later cups for rubber tapping.
(6) Coagulating pans for the rubber industry.
(7) Tea leaf collecting baskets.
(8) Water bottles and other utensils for servicemen.
(9) Aluminium powder for phrotechnic and explosives.
(10) Tubes for the radio industry.
(11) Aluminium wires.

Virgin aluminium production

The steps above shown were not adequate to rectify India's deficiencies in regard to aluminium. It was not enough to refine aluminium scrap ; virgin aluminium must be produced and for this India has the resources as will be shown below.

The raw materials for the manufacture of aluminium are (1) bauxite (2) cryolite and (3) caustic soda. Bauxite, the ore of aluminium, is found in many parts of India—notably at Belgaum and Tungar Hill in Bombay Province, at Katni in C.P., at Ranchi in Bihar Province, and in the Kashmir and Kolhapur States. For the economic production of aluminium, bauxite must have a minimum aluminium content of 52 per cent and a maximum silica content of 5 per cent. The deposits at the places just enumerated fulfil these conditions. In fact, some of the Indian bauxite deposits contain as much as 62 per cent of aluminium oxide. The total reserves of bauxite in India are very large, perhaps of the order of 250 millions tons. Cryolite must be imported, but the quantity required is small, compared with the tonnage of the aluminium processed. As for caustic soda, increased supplies are now being made in India.

The production of aluminium is an electro-metallurgical process. Electric power plays a vital part in aluminium manufacture and the supply of cheap power is therefore a material factor. Canada, which is today the largest producer of aluminium, has no workable deposits of bauxite, and has to get the one from South America, which is pretty far. But Canada, has cheap hydroelectric power, and on this is based Canada's pre-eminence in the aluminium industry. India has also large hydro-electric resources, although only part of them have been developed.

With such large deposits of bauxite and with great possibilities of making cheap power, it is a pity that India has not so far developed an aluminium industry. Cloth and food are prime essentials, and it was found easier to set up textile and sugar mills ; all available capital, therefore, went into such enterprises. In 1937, British Canadian experts made a survey of India's potentialities for aluminium production. One result of this Mission was the establishment of the Aluminium Production Company of India Ltd., now known as Indian Aluminium Company Ltd. At the same time, another company called the Aluminium Corporation of India Ltd., was also incorporated. Both these concerns started work before war broke out.

The plan of the Indian Aluminium Company, Ltd., is (1) to produce alumina from bauxite at Ranchi (near the ore deposits), (2) to convert alumina into aluminium ingots at Alwaye (Travancore) by utilising the cheap hydro-electric power generated at the Pallivasal Works located in the high ranges of Travancore, and (3) to roll the ingots into various shapes in their mills at Belur (Calcutta), in the area where the biggest demand for aluminium is likely to arise under the present conditions. Of the three parts of the scheme, the second and the third have been carried out ; India today produces virgin aluminium, and this is being rolled into sheets, etc., for sale to the Manufacturers.

The third part of the scheme materialised first. The Belur Rolling Mills came into operation in 1941 and began using imported Aluminium ingots and scrap till the second part of the scheme materialised. The rolling of aluminium ingots into sheets, bars, casting, etc., calls for high metallurgical training and practical experience. The Blur Mills were installed by Canadian Aluminium experts and is said to be complete in equipment with the most modern mills in North America. No doubt the largest for aluminium in India is in the sheet form ; but rolling into other forms is also necessary if the mills are to be put to their fullest use. As there is bound to arise a great demand for aluminium foils for tea chest linings as well as for packing of foodstuffs and tobacco, foil rolling seems necessary. Similarly, rod mills and wire-drawing capacity may also be required if India takes up large-scale electrification. Aluminium alloys, casting, rolling of structural sections, die-castings, etc , will also be called for as industrialisation advances.

The second part of the scheme, i.e., the reduction of aluminium ingots, has also materialised since, and virgin aluminium was made for the first time in India in March 1943, in the Indian Aluminium Company's Works at Alwaye in Travancore State. The raw material has a long way to go, largely in quest of the cheap electrical power available in Travancore State. This marks a distinct stage in the history of the aluminium industry in India ; it may also be regarded as the largest single metallurgical development in India sidce the establishment of the iron and steel industry early in the century.

Although 46 furnaces have been installed, only 28 of them are now working due to war-time limitations on the supply of power. The present total annual production is between 1,600 to 1,650 tons of ingots. For the present this meets India's war-time requirements. With an increased supply of electric power,—the present consumption is only 4,600 K.W.—the production can be increased to 2,500 tons. The eventual capacity projected is 5,000 tons per annum (provided the supply of electrical energy can be increased to 14,500 K.W.).

The reduction of alumina into aluminium is done by an electrolytic process ; the mineral cryolite being used as electrolyte. The electric furnace used is a shallow oblong steel shell, with a carbon lining which acts as a cathode. Above

it, is a carbon electrode or several electrodes, which act as an anode. The carbon used for lining must be of the highest possible purity, and is generally prepared from petroleum coke. The alumina is gradually fed into the molten electrolyte and by the passage of the electric current is reduced to aluminium which settles at the bottom of the bath, whence it is drawn off and poured into ignots. For every pound of metal produced, about 10 kilowatt-hours of electricity and 1½ pound of carbon electrode are consumed. The process is not very complicated, but a high degree of technical control is repuired if the best results are to be obtained.

The Alumina so far used at the Alwaye Works is imported, but soon production of alumina from bauxite will take place at Ranchi. The process of making alumina from bauxite is as follows. The bauxite is crushed, calcined and ground to powder. The powered bauxite is digested under heat and pressure with a solution of caustic soda, the aluminium oxide going into solution, while the impurities, mainly silica fenric-oxide and titanium oxide, remain undissolved. These are allowed to settle out while the caustic liquor is drawn off, cooled, diluted and the aluminium oxide precipitated. This is then put through a process of filtration and washing and finally calcined for use in the reduction furnaces. The resultant alumina (aluminium oxide) is a fine white crystalline powder.

With the carrying out of this process at Ranchi, the whole of the Company's comprehensive scheme of aluminium manufacture will be a *fait accompli*, and India will have a full-fledged aluminium industry. The enterprise and capital for this new industry have so for come from Canada and Great Britain. It is generally an advantage to start an industry with the best technical skill and experience from a country where it has been successfully worked. A scheme is, however, in progress for giving to India a proper share in the capital and management of the Company. Both at Belur and at Alwaye, Indian technicians are being trained and those who are trained obtain responsible positions in the Works.

The Aluminium Corporation of India Ltd., have had to encounter many difficulties and for some time progress was slow. Their smelter is located in Asansol (Bengal), and power will be supplied by a steam-generating plant fed with coal from the colieries nearby. They have taken up production from the first processes, and their bauxite refinery has started production. The production plant has also begun to work and some aluminium ingots have lately been produced. The quantity produced is small so far. The rolling mill is still being assembled and it may take another year for the production of sheet to commence. (See Appendix I).

Post-war prospects

Before the war, Germany and North America were the largest producers of aluminium. Out of a total production of 250,000 tons in 1935, Germany accounted for 72 per cent and North America 21 per cent. During the war the production of aluminium has largely increased in all the belligerent countries, and it is believed that the present world production is 8 to 10 times that of pre-war. Among the Empire countries, Canada has taken the lead in aluminium production and the Aluminium Company of Canada exerts a dominating influence over the industry. The consumption in India was about 3,000 tons in 1938 when the world's consumption was about 600,000 tons. The capacity for aluminium production in India, so far established, is only for 5.000 tons. As the Indian consumption in post war years is likely to be larger than the pre-war consumption, there is every reason to believe that the whole of the Indian production will be required in the country.

Competition from imports will hardly affect the utensils manufacture, which is well established, but in the case of virgin aluminium and sheets, it is a matter to be reckoned with. For one thing, the freight charges for bringing aluminium from distant foreign countries is much lower than the transport charges within the country. Even apart from this, import prices are likely to be lower. The price of aluminium in Canada today is only 16 cents, or

about 8 annas per lb. In India before the war scrap used to sell at 4 annas per lb., but it rose to Rs. 2-8-0 in war time, and it now sells at the controlled rate of Rs. 1-12-0 per lb. This price will come down with the stabilisation of the market after the war; but the question is whether the Indian production cost of virgin aluminium ingot and sheet will be low enough to enable the same to be sold at competitive prices, especially if the large aluminium interests of America or elsewhere make a determined bid for the Indian market. As mentioned above, cheap power is the governing factor in the aluminium industry and if India's hydro-electric resources (estimated at 27 million horse-power) are developed, power can be abundant and cheap, and India can withstand outside competition. Transport also is important in this connection, and this in turn largely depends on cheap electricity.

PART B.—ENGINEERING INDUSTRIES

General

The engineering industry of India had its beginnings well over a hundred years ago. A few firms in the Presidency towns were engaged in making bridges and repairing engines, and with the introduction of railways, this kind of work expanded. Railway companies indeed maintained their own workshops. but the assistance of private firms was needed for the construction of bridges and the fabrication of general steel structures. Wagon building was also left to private firms, and along with this went the repairs and replacement of parts like buffers, axle boxes, vacuum brake fittings, etc. Thus a heavy engineering industry came into existence in India mostly located in Calcutta, with large firms like Braithwaite & Co., Burn & Co., Jessop & Co., Britannia Engineering Co., Saxby and Farmer and others. Apart from undertaking structural work of all kinds, most of these firms made wagons and were engaged in mechanical engineering works also. These firms undertook the construction of bridges, etc., for Provincial and State Governments also.

For long, private industry was undeveloped, but with the establishment of Jute mills, cotton mills and sugar factories, mechanical engineering industry expanded and machinery like hydraulic presses came to be made in the country. Repairing work of a varied nature also arose. These engineering firms were started mostly by British enterprise. In 1924, the Indian Engineering Association had 40 firms as members with a capital investment of Rs. 12 crores. This excluded the small firms scattered about the country. The total number of persons engaged in the Engineering industry was estimated at 75,000 in 1924.

For long, not only the machines but the iron and steel goods required for various purposes, were imported from abroad. With the establishment of Tata Iron & Steel Company, the external dependence on iron and steel goods gradually diminished. Rails, structurals, tin-plates, galvanised sheets, wire nails, etc., came to be produced in India in large quantities. Lately, wheels, tyres and axles have also come to be made in India. Foundries have been started and castings in iron and steel are being made in increasing quantities Forgings have also been made, although still in an undeveloped conditions.

As shown above, the Indian engineering industry has long been dependent on Governments as its chief employer. Therefore, the Government's policy in regard to capital expenditure has had a great influence on this industry. After the last war, a period of expansion followed, especially after 1925, and this brought much work to the engineering industry, but after the world economic crisis of 1929, all changed. The Governments, Central and Provincial, and Railways cut down their capital Works programmes and the engineering industry fell on slack days. The total consumption of structural steel in 1934 was hardly 50 per cent. of what it was in 1929. Consequently India was not able to absorb all the structural steel produced in the country. A cheese paring policy was followed in the matter of wagon building and the result of this is now being reaped. Such was the condition of the engineering industry at the outbreak of the war.

In 1939, the Indian Engineering Association had 58 firms as members and the total number of employees was about 84,000. By 1943 the membership rose to 87 and the number of employees went up to 150,000. This Association is affiliated to the Bengal Chamber of Commerce. Another association called the Engineering Association of India has also been started lately and this has already got a membership of 45. This association is affiliated to the Indian Chamber of Commerce.

Engineering industry may be dealt with under (i) Tools, (ii) Mechanical, (iii) Structural, (iv) Electrical, (v) Shipbuilding and Marine Engineering, (vi) Welding and Press Work. Wagon building and the making of armoured vehicles combine both structural and mechanical operations, but as structural work is the more prominent, we will deal with then under structural engineering.

SECTION III—TOOLS

1. Machine Tools

General—The term 'machine tool' is used for all mechanical contrivances for cutting, forming, abrading, polishing or otherwise working or treating wood or metal. Machine tools are themselves machines, and without them modern industry cannot function.

Machine tools may be for general purposes or for special purposes. Some special purpose machine-tools have been made in India, but the great majority of the machine-tools made here are of the general-purpose type. The following are the machine tools concerned :—

(1) Lathes, capstan lathes
(2) Drilling machines
(3) Chucks
(4) Planning machines
(5) Shaping machines
(6) Milling machines
(7) Sawing machines (metal and wood)
(8) Grinding and polishing equipment
(9) Presses, punches and shearing machines
(10) Welding furnace equipment
(11) Miscellaneous

Before the War

Although there was no regular machine tool industry in India before the war, various machine tools were made in the larger engineering workshops. for instance, hydraulic presses were made in large numbers for the jute and cotton mills, especially by Jessop & Co. Milling machines and planers were also made occasionally, but the bulk of the machine tools used in India were imported and especially in the case of lathes and ordinary milling machines which are made on mass production methods, the import prices were much lower and their production in India was uneconomical.

Just before the War the great majority of the machine tools were imported. In 1937-38 machine tools worth £228,251 were imported. Of this nearly 64 per cent. came from the U. K; 15 per cent from Germany; 9 per cent from the U. S. A. and 5-8 per cent. from Japan. Even before the War the U. S. A. had a large machine tool industry and had also an exportable surplus. The industry in the U. K. was smaller and she herself depended on American import for certain kinds of machine tools. Japan made a bid for the Indian market, but her machine tools were of an inferior quality. The Australian machine tool industry started before the War and great progress has been made during the War.

In War Time.

Even before the war, Jessop & Co. had been considering the question of manufacturing machine tools on a production basis, and had actually commenced manufacture in 1940. About the same time a number of other firms became interested, and they enlisted the assistance of the larger Import Houses who were able to supply them with the necessary technical information and help them in planning their manufacture and training their workmen. Of these firms the most prominent were India Machinery Co. Ltd., Dassnager, Brittania Engineering Co. Ltd., Titaghur, Cooper Engineering Co. Ltd., Satara, Kirloskar

Bros. Ltd., Kirloskarvadi. These firms began with very simple machines such as Cone Pulley Head Lathes, Shaping Machines, Drilling Machines, Presses and Hacksawing Machine.

When the Machine Tool Controller was appointed early in 1941, the above firms were producing Machine Tools each at the rate of approximately two to three per month. At that stage Italy had not entered the war and imports from U. K. and U. S. A. were more or less unrestricted although their import into British India was controlled by license.

With the collapse of France and the entry of Italy into the war, India was virtually cut off from all imports from the U. K. and U. S. A. and was forced to rely on her own production and the very small imports of low-grade Machine Tools from China and Japan. Australia was unable to meet any of India's demands.

The Machine Tool Controller was therefore faced with the task of meeting by local production as much as 60 per cent. of India's requirements within the shortest possible period. This involved a rapid expansion of the industry. With this target in view every manufacturer who showed any interest whatever and possessed the necessary plant was encouraged to take up the manufacture.

At the outset licences were freely granted to firms willing to make machine tools, but the response was poor and it became obvious that the industry needed rationalisation if it was to survive. Obviously a scheme of rationalisation both of "orders" and of "manufacture" was necessary.

By the end of 1942 the production of machine tools in India had risen to approximately 150 per month, but this figure included machines of very low grade and quality and only usable on the roughest work

The Machine Tool Controller realising the necessity of having a reserve supply of machine tools to draw on, and having been refused a reserve of imported machine tools, evolved a scheme for the expansion of five of the more experienced machine tool manufacturing firms in India, with a view to increasing their combined output by a further 100 machines per month. Schemes were drawn up for balancing these five firms, existing plants, and the U. K. and U. S. A. authorities agreed to supply the required plants.

In furtherance of this expansion scheme, the Machine Tool Controller, U. K. agreed to meet the British India Machine Tool Controller 's request to send a team of technicians to assist the Industry on technical manufacturing problems. Mr. Oldfield and Mr. Trubshaw were sent out at the head of this team of technicians who were posted to the various manufacturing sections in Bombay, Lahore and Calcutta.

The first of the technicians' tasks was to survey the Industry with a view to rationalisation and secondly to lay down standards by which manufactured machines could be distinctively graded according to their accuracy and quality.

This was achieved and the Machine Tool Controller placed bulk orders on some 25 firms who were considered by the Machine Tool Engineering Adviser (Mr. Oldfield) as capable of producing machine tools of high grade and on semi-production basis. These firms were given assistance by way of balancing plant in order that production may be accebrated.

Bulk ordering of Machine Tools by Government.—About that time Government also decided to take over the ordering of all the machine tools required for the country and their distribution. Thus all orders for machine tools even those by industrial users, were aggregated and contracted for by Government, who also arranged for the re-sale of the machine tools to the industrial users. It was for rationalising production that Government took up this burden on itself. It was not advisable to allow too many people to take up machine tool production. Licencing had to be limited to those who had fair chances of success in making machine tools of reasonable standard. It was also necessary to make some firms specialise in this and even they should limit themselves to production on a mass manufacture basis of only a few types of machine tools for which they had the equipment. Such has been the principle which regulated machine tool production in the U. K. and it is ultimately in the best interests of any country.

Most firms in India took up the manufacture of machine tools as a side-line. The only concern set up for the sole purpose of producing machine tools was Mysore Kirloskar, Ltd. (Harihar), which owes its origin to the well-known Kirloskar Bros. of Kirloskorwadi a firm which has long been engaged in making pumps and agricultural implements. The new company started work at Harihar in 1942.

The idea of industrial concerns making their own machine tools was also deprecated. At a time when there were no specialised producers, this was perhaps justified, but this has to be discouraged when production on a mass manufacture basis is adopted.

Therefore the policy of the Government based on (a) selection of the most promising firms for specified number of items and (b) bulk manufacture, seemed essential for fostering the industry in the present circumstances. The country would definitely gain by a dozen selected factories engaged in the mass manufacture of machine tools producing 360 machines a month between them then by the 250 firms mostly ill-equipped, scrambling among themselves for orders. Such a policy was therefore boldly initiated by Government and had the support of the Machine Tool Advisory Panel.

Transition to normal trade.—Such a system of bulk ordering by Government was indeed helpful to the industry, but its continuance for an indefinite period of time was inadvisable in the interests of the country. Therefore, early in 1944 Government decided to revert to the usual trade channels for the acquisition of new machine tools manufactured in India; but at the same time to preserve is on the basis of the rationalisation measures were enforced through a licensing system. This was a fresh step in the return to the normal trading and the competitive market of high grade machine tools. This system has come into force from 1st April 1944.

Under the new system the old practice of bulk forecasting and the placing of bulk orders on firms has been abandoned; instead licences are being issued to manufacturers for the production of machine tools and they would bear the financial responsibility for their programmes in the same way as they did in peace time. No manufacture, however, might produce machine tools without the Controller's licence. Manufacturers shall intimate to the Controller the types and quantities of machine tools they propose to produce and if he is satisfied licences are issued.

No machine tools can be ordered by a private industrial user except through the Controller. The users apply through the Regional Representatives to the Controller for the authorisation to acquire them. Such Regional Representatives are stationed at Bombay, Madras. Cawnpore and Lahore. Having received such authorisation the industrial user will be at liberty to enter into direct purchase negotiations with any individual machine tool manufacturer or his Agents or dealers.

Statutory maximum price will from time to time be published for new machine tools in future to be manufactured in India. These statutory price, whilst imposing a limit on the price at which newly manufactured Indian machine tools can be sold will not debar sales at a lower price.

To assist industrial users in their negotiations with the manufacturers, a list of manufacturers showing the types and grades of machine tools they are licensed to manufacture would be furnished on application to the Machine Tool Controller, (for list of the markers of high grade machine see below).

Thus the revised scheme aims at a partial decontrol. So far as Government purchases are concerned, it was intended to get back to peace time conditions, i.e., the usual methods of purchases including the teneder system. Manufacturers holding licences from the Machine Tool Controller will be assisted in obtaining there requirements of steel and other raw materials in the same manner in which they were assisted under the Bulk Order System. For any other assistance manufacturers should apply to the Controller and the same technical assistance, as has hitherto been, will also be available to manufacturers.

In the matter of machine tools of classes or grades that cannot be made in India and can only be secured form overseas, importation will be arranged in

the normal way. Such importation, however, will be arranged only in exceptional circumstances. The policy thus continues to be the same as formerly i.e., to reduce imports as much as possible. All indents will be scrutinised by the Tools Division of the D. G. M. P. with a view to investigating the possibility of supply from Indian sources.

Growth of Production.—Before the war hardly 100 machine tools were made in a year. As a result of the encouragement given by the Government, about 350 machine tools (including chucks) are now (1944) being made every month, i.e., about 4,500 machine tools a year. This is highly gratifying: it also indicates a substantial increase of large scale industrial production in the country.

With the adoption of India as the first base for operations by the South East Asia Command, it has become extremely important that India should have an adequate supply of suitable machines for the repair and maintenance of aircraft and aircraft ordnance, naval and civilian ships, motor transport vehicles, locomotives and rolling stock, etc. Advisory Mission of experts, headed by Sir William Stanier, has lately arrived in India for taking stock of India's resources in this line and to recommend such adjustments as are essential.

Grades of Machine Tools.—There are three grades of machine tools—I, II III. Grade I is equivalent to imported machines. Grade II indicates an accuracy which is 150 per cent, wider than Grade I. Grade III indicates an accuracy which is 250 per cent, wider than Grade I. Grade III is only suitable for very rough work. Unfortunately the majority of machines so far made in India are of Grade III types, not suitable for accurate work and therefore in most cases not suitable for Government requirements, Ordnance factories and Railways. In the case of the more common types of machine tools, however, several manufacturers in Indian come up to Grade I levels.

Post-war adjustments

Regarding the post-war adjustment of the Industry, it should be able to take care of itself, if the Industry now takes seriously the Machine Tool Controller's policy to produce high-grade Machine Tools at competitive rates and in a competitive market. This policy will mean that the inefficient firms who are unable to manufacture machines economically and place on the market a high quality machine at a competitive price will find the going too hard and in all probability will revert to their per-war activities to which they are more suited. Towards this end the Inspection Branch of the Indian Stores Department has offered its co-operation to inspect machine tools at a nominal fee of one per cent, of the contract value. This is a generous gesture on the part of the Government to assist the Machine Tool Manufacturers in maintaining and improving the standard of accuracy and quality of Indian made tools.

It is not likely that there will be serious unemployment in the Machine Tool Industry, as once an artisan is trained for machine tool manufacture, he is normally considered capable of tacking any form of mechanical engineering work. On the other hand, there will be a dearth of trained men in India if industrialisation is accelerated.

As for raw materials high class steels which had formerly been imported are now being manufactured in India and if the forward programme of the steel producers is carried out the need for imports would greatly narrow down.

List of Principal Machine Tool Manufaturers in India

Names of firms	*Tools made and Grade*
1. Jessob and Co.	Lathes (Grade I), Circular Cold Saws (Grade I).
2. Cooper Engineering Works, Satara . .	Caustans (Grade I), Drilling Machines (Grade I), Shaping Machines (Grade I).
3. India Machinery Ltd., Howrah . .	Lathes (Grade I), Planning Machines (Grade I), Shaping Machines (Grade I), Slotting Machines
4. Mysore Kirloskar Ltd, Harihar, Mysore .	Lathes (Grade I), Drilling Machines (Grade I), Milling Machines (Grade I), Shaping Machines (Grade I).
5. Britannia Engineering Co. Ltd., Titaghur . .	Lathes (Grade I), Grinding Machines (Grade I), Hacksawing M/C (Grade I).

	Names of firms	*Tools made and Grade*
6.	Maya Engineering Works, Calcutta . .	Drilling Machines (Grade I), Grinding Machines (Grade I).
7.	Hind Machines Ltd., Howrah . . .	Drilling Machines (Grade III), Milling Machines (Grade II).
8.	Sir Ganga Ram Hari Ram, Lahore Cantt.	Lathes Grade I).
9.	Investa Machine Tools and Enineering Co. Ltd., Bombay.	Lathes (Grade 1).
10.	Heroes Engineering Works, Calcutta .	Lathes (Grade III).
11.	S. L. Dutt and Co., Calcutta . . .	Lathes (Grade III).
12.	Jay Engineering Works, Calcutta . .	Capstan Lathes.
13.	New Standard Engineering Co., Bombay .	Drilling Machines (Grade III).
14.	Practical Engineering Ltd., Bombay .	Radial Drilling Machines.
15.	Richardson and Cruddas Ltd., Bombay .	Planing Machines (Grade 1).
16.	Batala Engineering Co., Punjab . .	Planing Machines (Grade III).
17.	Oriental Engineering Works, Lahore .	Shaping Machines (Grade III).
18.	Alfred Herbert (India) Ltd., Calcutta .	Haksawing M/C (Grade II).
19.	Unique Engineering Co. Ltd., Punjab .	Bandsaws (Grade III).
20.	Victor Crane and Co., Ltd, Sialkot .	Bandsaws (Grade III).
21.	G. G. Dandekar Machine Works Ltd., Bhiwindi.	Circular Saws (Grade III).
22.	Kundan Lall and Sons, Ludhiana .	Circular Saws (Grade III).
23.	Indian Sewing Machine Manufacturing Co., Lahore.	Lathes Chucks (Grade I).
24.	All-Round Supplies, Cawnpore . .	Acetylene Generators.

2. Small Tools and Implements.

Under Small tools are included (1) hand tools such as pick axes, shovels chisels, hammers, screw drivers, spanners etc, (2) metal cutting tools like twist drills, and (3) wood working tools

Pre-war

Indian manufacture was supplying before the war only 10 per cent. of India's total consumption of small tools, the remaining 90 per cent. being imported The centres of production for light tools were principally Calcutta and Bombay, because dealers in these tools were centred in these towns, and in the Punjab for heavier items of agricultural tools.

Taking agricultural tools separately, referring to articles like pick axes, shovels, kodalies, powhras, etc., Indian production was large enough to meet a good share of India's demands. Agrico Ltd., Tatanagar. Mysore Tools Factory, Mysore, and Metal Works, Shoranur (Cochin State) were the principal producers. The production of Agrico used up nearly 5,000 tons of steel.

War time.

In the war time production of small tools has increased due to stoppage of imports and increased war demands. The types of tools produced require very little by way of extra plant and machinery, the principal extension being in the number of blacksmiths' fires and the training of labour in the production of new articles. Certain extensions and improvements in steel production were made and special plant was imported by Tatas for pick axe eyes. The lines of production of small tools in war time cover some 200 types of which a selected few are the following :—

Articles	*Production figures (annual)*
Pick axes	8,00,000 *Nos.*
Shovels	10,00,000 ,,
Hammers	5,00,000 ,,
Pilers	3,00,000 ,,
Carpenters' chisels	3,00,000 ,,
Screw drivers	3,00,000 ,,
Drills	4,00,000 ,,
Implements entrenching heads . . .	3,00,000 ,,

The present production of hand tools is sufficient to meet India's requirements in full. But the metal cutting tools required are almost all imported except for the India Tools Manufacturers (Bombay)'s production of twist drills which is only 2/20th of the requirements. The manufacture of these tools require very special machine tools which U. S. A. and U. K. have not been able to spare. The requirements of wood working tools are also almost entirely met by imports. In war time imports of these tools have increased enormously owing to the huge programme of the Timber Directorate of the Supply Department.

The value of orders placed by the Government during 1942 came to about Rs. 21,00,000 per month, and about Rs. 9,00,000 per month in 1943, No special assistance is given to the industry by the Government and no formal control is exercised, except in the case of Agrico's production which is controlled by the Small Tools Directorate of the Supply Department.

Agrico's entire production of pick axes (coming to abont 90.000 a month) and hammers is taken up by the Supply Department. But its production of hoes (about 1,40,000 a month is not controlled except through the controlled supply of steel, and only a part of hoes produced goes to the Government orders. Its consumption of steel in war-time comes to about 10,000 tons per annum, almost double the pre-war figure.

In the matter of agricultural implements, consisting of ploughs, harrows, cultivators, sugar cane crushers, sugar cane pans, decorticators, chaff cutters, etc., production has been reduced during war time owing to lack of some of the raw materials and to pre-occupation of the manufacturers with other more profitable products. The raw-materials, chiefly steel and cast iron, are purely indigenous but some quantity of discs for use with disc harrows and discs ploughs and knives for chaff cutters used to be imported. The chief producers of agricultural implements are the following. (There have been no new additions in war time):—

(1) Kirloskar Bros, Kirloskarwadi.
(2) P. S. C. & Sons, Coimbatore.
(3) Cooper Engineering Ltd., Satara.
(4) Batala Engineering Works, Batala,
(5) Beharimul Guzarimul, Patna.
(6) Renwick & Co. Kushtilia.
(7) Bahri Engineering Co., Jamshedpur.

Post-war

Demands for heavier kinds of tools, like pick axes, shovels, mamooties, crow bars, etc., will be met in full by Indian production. In the matter of agricultural implements also, Indian production can meet the full peace time demands, unless the war time demands for more lucrative production continue in postwar years also. In such a case, the Government may do well to impose statutory restrictions on such production, so that, sufficient capacity may be diverted to these items. In the the matter of these heavy tools and implements, the quality of Indian goods is good enough and they can compete successfully with imported ones without any special assistance from the Government. But in the case of special tools such as files, which require special equipment, the present Indian products may not compete with imports, since the Indian producers lack the special equipments. And as the prospects of export trade are not great, the internal demand by itself is not large enough to justify the installation of special plants which require a heavy capital outlay. The plant and personnel now used for the production of the special tools could be diverted to the production of simpler and heavier types of tools and implements, after the war.

SECTION IV.—MECHANICAL ENGINEERING INDUSTRY

General.—Under this name it is proposed to group together the various industries engaged in making and repairing machines and other mechanical appliances.

Several of the older engineering firms are fited up for both structural and mechanical work. For instance. Jessop & Co. has separate workshops for mechanical and structural engineering. The same is the case with Burn and Co., Garden Reach Workshops. James Alexander & Co. (all at Calcutta) Richardson & Cruddas, Bombay and Herman & Mohatta, Karachi.

There are other firms, and they are a large nnmber which are principally engaged in mechanical engineering, Such are:—

Jay Engineering Works, Calcutta.
India Machinery Ltd., Dum Dum (Calcutta).
Britannia Machinery Ltd., Titaghur.

Cooper Engineering Works, Satara
Kirloskar Bros.,Kirloskarwadi
P. S. G. & Sons, Coimbatore.

A good number of these firms specialise in steam and water fitting which have become an important engineering activity as a growing number of house came to be built in Indian towns with water, gas and electrical conveniences.

At the outbreak of the war an opportunity was given to make machines and other appliances which were more important, but owing to inadequate equipment and lack of proper technical knowledge this opportunity has not been fully utilized except by a few firms

The progress of mechanical engineering depends also on the availability of the special classes of steel required for the machines and on the growth of the forging trade. As shown already, India has lately made considerable progress in the manufacture of alloy and tool steels. These are essential for making machine tools and manufactures' machinery. So far they are only available in bar and sheet form. Therefore, only comparatively small machines can be built yet. With a little more advance it would be possible to make larger machines also with India.made materials.

A complete survey of the recent advances in these industries has not been possible ; many of these developments lie outside the scope of the Supply Department's activities. Some information has been gathered under the following heads:—(i) Pumps, (ii) Oil Engines, (iii) Water Fittings, (iv) Weighing Machines, Jacks, etc., (v) Manufacturers' Machinery, (vi) Road-making Machinery.

1. Pumps Centrifugal And Hand Operated

These are used for lifting water. Only three firms worth mentioning were manufacturing centrifugal pumps before the war. They are Kirloskar Bros. Ltd.' P. S. G. & Sons, Coimbatore and Jyoti Ltd., Baroda. The Government repuirements of centrifugal pumps are still being met by these firms. But after the outbreak of war, several small firms have begun production to meet the civilian demand which has increased as a result of the increasing activity in regard to food production. The production of centrifugal pumps, however, has been restricted due to the limited supplies of ball and roller bearings, which are now imported from U. S. A., and are strictly controlled, because of short supply. Although these are not essential for the operation of most types of pumps, the firms are disinclined to modify their pre-war designs even at the cost of restricted output.

The hand -operated pumps were also being manufactured in India by a large number of firms, and except in special cases India was self-supporting in this type of equipment before the war. The position has improved considerably in war-time with many more firms entering the field of production.

After the war, the three major firms manufacturing centrifugal pumps may expand their production as a commercial measure. In the case of the hand-operated pumps, the present position is not likely to change in the post-war period.

2. Oil Engines

Before the war, Indian production of prime movers was negligible. Two firms were engaged in this industry, the first one being Cooper Engineering Ltd., Satara, who manufacture a range of horizontal slow-speed engine. The other firm is Kirloskar Bros., who manufacture vertical single and twin cylinder engines. Coopers alone have been able to expand production in war-time. This expansion is only a recent development and is largely dependent on the support given by the Government. They have also recently introduced one new high speed horizontal type of engines. The estimated production for 1944 is 650 engines of various types in their present range. The Kirloskar Bros. have had to stop their production in war time, since the importation of most of the essential components of their engines has stopped.

After the war, if engines made in India are able to reach the standard of the imported engines, there should be no difficulty of selling the whole Indian output locally. But engines for electric supply will have to be imported' because no local capacity exists for the manufacture of multi-cylinder high speed diesel engines.

3. Water Fittings

There was no organised production in India of water fittings of stendardized designs, and India's requirements were mostly met by imports. When imports dwindled in war time, attempts were made in India to develop the production of these articles, and the Governmeut encouraged the production the firms large orders and controlled raw materials. But most of the Indian firms were lacking in technical knowledge, and were merely copying the work of others Hence the Supply Department has been trying in recent months to rationalise the types of sluice valves and water fittings which are in large demand by the Department, in an endeavour to assist the manufacturers to increase the ontput to an acceptable specification.

The following firms are engaged in the production of water fittings:—

(1) Annapura Metal Works, Calcutta.
(2) T. K. Das, Calcutta.
(3) G. T. R. & Co-, Dum Dum.
(4) J. N. Dass, Calcutta.
(5) Garlick & Co., Bombay.
(6) Kirloskar Brothers, Kirloskarwadi.
(7) Ashok Manufacturing, Lahore.
(8) Saroup & Bansilal, Lahore

The progress of the industry had been seriously handicapped by the lack of certain key items of materials, notably, forged manganese bronze for spindles of sluice valves. As a result of encouragement given by the Supply Department, the production of forged manganes bronze has been unbertaken by W. Leslie (Lahore), anb J. N. Dass (Calcutta) has made the spindles.

After the war Indian production of the small water fittings, such as bib cock, globe valve etc. now being produced here in quantities to an accepted specification' may continue to exist without much contraction. But in respect of other items of water fittings' imports of superior quality are likely to dominate the Indian market.

4. Weighing Machines, Jacks, etc.

About half a dozen small firms in India were manufacturing weighing machines before the war, but their total output was small. Production in war time has expanded to the full capacity of these firms. Not many new plants have been installed. The increase in production has been achieved primarily by concentration on one type of goods to the exclusion of other minor products which the firms were producing in peace-time. The Indian production may not dwindle after the war, since the simpler types of machine can be made at competitive rates. The following firms are engaged in making weighing machines of different kinds.—

(1) Auto Seals Manufacturing Co., Calcutta.
(2) Avery & Co., Calcutta.
(3) Indian Machinery Ltd., Dasnagar, Howrah.
(4) Bharat Weighing Scales and Engineering Syndicate, Calcutta.
(5) Star Iron Works, Libuah.
(6) Jessop & Co., Calcutta.

Jacks.—The production of jacks which existed in India before the war, increased due to the very large demand for vehicles in war time and due to the fact that the vehicles which come under the Lease/Lend agreement have no jacks with them. A rationalised range of jacks has been agreed to for Indian manufacture. In 1943, 15,000 jacks were produced in India. The estimated production for 1944 is 50,000 jacks'. After the war, the present demand may fall off, because the vehicles imported will have jacks with them.

Chain.—Two small firms in Lahore area produce a small output of chain, which is only a fraction of the total indigenous demand. The quality is poor and is untested. The efforts of the Government to increase the manufacturing capacity have not been successful so far.

5. Manufacturers' Machinery

[This is a large subject with wide ramifications—only a few scattered facts have been collected and they are given below.]

Textile Machinery.—India's big textile industry of cotton, jute, silk, and woollen, uses considerable quantities of textile machinery annually for replacement and extension of work. The need was being met entirely by imports worth about Rs. 2½ crores per annum.

Lack of sufficient imports of textile machinery has been one of the serious handicaps experienced by the Indian textile industry in war time and it has prevented them from making the necessary expansions to meet the increased war demand. To make good this deficiency, an Indian company was started in 1941, under the name of Textile Machinery Corporation Ltd., with a paid up capital of Rs. 25 lakhs to manufacture cotton textile machinery and parts. Two factorys were set up by the company, one at Gwalior and the other at Belghurriah (Bengal), and plant and machinery worth about Rs. 18½ lakhs are installed there. The production capacity of the company is about 2,000 looms and 100,000 spindles annually, which represents only 20 per cent. of the replacement requirements of the existing cotton textile industry (the cotton mills in India were employing 10 million spindles and 200,000 looms before the war). This capacity could be increased. If precision machine tools and other equipment are made available. The initial programme however, was only to produce 250 spinning frames and 2,000 looms annually. But even this modest programme could not be carried out due to war conditions. Now only the Gwalior factory is working on textile machinery, the other one being engaged for the present in producing war materials. The Gwalior factory is now making about 1,000 looms annually. Spinning frames are also being manufactured, but their production is not developed fully. Power looms can also be made here with raw meterials locally available. For the manufacture of ring frames, steel rods, steel tubes and polished tin sheets are necessary and have to be obtained from abroad. But the Indian steel industry may be able to supply most of these after the war. The machinery required for the industry, consisting mostly of precision tools and automatic machines of various types have all to be imported. Skilled labour necessary can be trained locally. After the war, the industry, now only in an experimental stage, may make a bid to establish itself firmly. If it is not to succumb to the competition from imports of established reputation, special help may have to be given to this infant industry.

Dairy Machinery.—This heading refers to such items as cream separators, pasteurizers, milk coolers, milk bottling machines, etc. The only item being produced in India at the moment satisfactorily is the 'Aluminium Vats' for milk coolers and receivers. This consists of sheet of aluminium shaped into large vessels with copper or brass tubing across them for circulating cold water. No other items can be made in India, and the production of even this began only in war time. Because of the shortage of shipping space, it was found that simple items of a bulky return like this could conveniently be produced in India, and its production does not call for any extensive machinery. Raw materials required are mainly aluminium sheets and copper tubing, and are obtainable locally. The only producer in India is Larsen and Toubro in Bombay. A few firms in Lahore were planning to undertake its manufacture, but they have not yet been successful, Government demands on the average call for about 6 Milk receiving vats and 6 milk coolers per annum. No special assistance is given by the Government to the industry except releasing of aluminium which is a controlled article.

After the war, the industry may not have much scope for development, since the items made here form the simplest parts of Dairy equipment and have no value without imported accessories which are not made in India.

5. Road Making Machinery

Bitumen Boilers and Mixers.—Bitumen boilers are vessels for heating bitumen or road tar prior to pouring on road surfaces. The boiler with a set of padles inside to be turned by means of a handle by human labour is termed a 'bitumen mixer'. Mixing is necessary to obtain quick heating and even distribution of solid bitumen inside the boiler. These articles are required, not only for road making, but in making bitumenous surfaces wherever required, as for example in ærodromes.

Before the war, Burn & Co., Calcutta, and Bhagat and Sons, Bombay, were manufacturing these items; the total annual production came to about 100 units and the price per unit was about Rs. 2,000.

In war time, demand for Bitumen mixers and boilers has gone up due to abnormal war demands for roads and ærodromes. This has led to about five other firms also taking up this line of production. The new firms are the following:—

(1) B. N. Chatterjee & Co., Calcutta.
(2) James Alexander & Co., Calcutta.
(3) Featherstone Engineering Co., Bombay.
(4) Sayaji Iron Work, Baroda.
(5) Herman & Mohatta, Karachi.

These are not new creations started exclusively for the production of bitumen boilers and mixers. They are workshops which were previously producing other items of machinery and have now been roped in to produce these items also. The total capacity of all the firms at present engaged in this line of production comes to about 1,000 units per annum. Production in 1943, however, was practically nil, due to lack of raw materials, especially mild steel. As a result of standardisation of design and larger output, the price per unit has gone below the pre-war price, and is only about Rs. 1,500 per unit.

The production of these goods require only ordinary workshop machinery such as shearing machines, presses and drilling and milling machines. Most of these are imported. Raw materials required are purely indigenous and consist of cast iron and mild steel. In the matter of skilled labour also there is no dependence on foreign countries.

Though the increased production was greatly encouraged by the Government, the industry is receiving no special assistance from the Government, except as called for in the normal way of production planning by the D. G. M. P., i e., wherever a bottleneck is experienced special steps are taken to try and dissolve the bottleneck.

In the post-war period, it is unlikely that imports will be large enough to crush the industry in India, especially because the stores being bulkly in nature, freight charges for imports will be prohibitively high. Nor is it likely that Indian demand for these goods will fall off, with the fall in the army demand in view of the possibility of an extensive public works programme including construction of roads and aerodromes. If on the other hand, the present production capacity is found insufficient to meet the post-war demand, there will be no necessity for imports, as any ordinary engineering workshop can manufacture these items, and several such shops exist in India.

Asphalt Mixers and Concrete Mixers.—There are revolving drums driven by power (internal combustion engine) used for intimately mixing cement or asphalt with stone chips, the former for reinforced concrete and road construction and the latter for road or aerodrome surface construction. These mixers are generally mounted on wheels and are hence capable of being towed about.

Except for the production of Millar's Timber and Trading Co., Bombay, India's demands for these mixers were being met by imports before the war. Imports from U. K. were available even early in 1944, though not in such

large quantities as before the war. It could not hence be said that the increase in production in war-time is due to any complete paucity of Imports. No new firm has entered this line, though Herman & Mohatta, Karachi and Cooper Connolly & Clifford, Bombay, have had plans drawn up for production of these mixers during war time, but have not started owing to various difficulties, the chief of which is the question of design being adapted to make use of indigenous engines. Production to 1943 was about 40 units, but there is capacity for about 60 units annually.

Production processes, call for extensive machinery and some of the processes such as cutting gears teeth, are rather complicated. Practically all the machinery used have to be imported. 80 per cent. of the raw materials for the mixer is found indigenously, being steel and cast iron. The remaining 20 per cent. of the raw materials, or rather components of the mixer consists of imported items, such as ball bearings, chains, clutch linings, etc. In addition, the entire driving unit, i.e., the internal combustion engine is imported. These engines are now being made in India, but they have not yet been adapted for use with concrete or asphalt mixers, the main difficulty being the adapting of the chassis to take the heavier and bulkier indigenous engine.

No special help is being given by Government to this industry except in so far as recommendations are given for release of engines whenever makers report that mixers are ready and are awaiting engines. It is anticipated, however, that if the present proposals for increasing production by using indigenous engines are put through, the industry will require special assistance for obtaining raw materials, etc.

If intensive building and road making programmes are undertaken after the war, the one firm now making these machines will be able to meet only small percentage of the total demands. The new production is unlikely to compete successfully with the imported article, and if more firms are encouraged now to begin production, extensive assistance will have to be given to them after the war to enable them to compete successfully with imports.

SECTION V.—STRUCTURAL ENGINEERING.

This is an important specialised industry and requires large workshops and extensive mechanical equipments to carry it on. But unlike many other industries the work carried on is mostly of the jobbing variety. In other words, the same machinery can be used for producing a large number of widely differing structures. The volume of work also varies considerably from time to time. In peace-time, a great variety of different kinds of structures are produced according to Individual, industrial or other use, and roughly they come under the following heads:—

(a) Railway and Road Bridges for Civil and Military purposes.

(b) Steel-frame structures, *e.g.*, Workshops, Warehouses, steel frames for residential buildings, crane gantries.

(c) Aeroplane Hangars of various designs and forms of construction.

(d) Jetties.

(e) Special plant supporting structures.

(f) Transmission towers.

(g) Oil well derricks and tripods.

(h) Ropeway structures.

(i) Pressed steel cisterns for water storage, welded steel cisterns for oil storage.

(j) Pressed and welded steelwork of miscellaneous types.

In war time also, nearly the same articles are produced except that in many cases they are military versions of the type produced in peace-time. Floating docks are the only important category newly added. One great difference between normal and war-time work is that while the lines of production were numerous and varied before the war, the tendency in war-time has been to concentrate on standardised unit structures on military lines. To this extent, mass production has replaced jobbing. This can be illustrated by taking some branches of the structural industry.

Steel Frame Structures.—In peace-time the buildings made were workshops, warehouses, sheds, steel frames for residential buildings, crane gantries for civil and military purposes, etc. Generally each structure was designed separately. In war-time military needs have been chiefly for standardised store sheds and other structures generally of smaller size, but required in large numbers. Therefore unit construction huts, called by various names, are the largest line of structural work. They are all constructed in such a manner as to enable standardised production to be carried out (*e.g.*, T. G. Sheddings, single and twin Nissen Huttings, etc.).

Aeroplane Hangars.—This was a small item before the war, because not many were required, but in war-time large numbers of aeroplane hangars—and big ones too—are needed and are being made, also on a standardised basis.

The following table will bring out the extent of increase under aircraft hangars:—

Year.	Tonnage.	Value (Rs.)
1939	793	6,60,066
1940	3,396	32,65,567
1941	135	56,154
1942	2,028	13,24,157
1943	10,450	44,65,992
1944—estimates	22,000	60,00,000

Bridges.—In peace time bridges for roads and railways were made by structural firms and each one was more or less designed for itself. The Howrah Bridge construction, by a joint concern of Messrs. Braithwaite, Burn and Jessop (B. B. J.), was the highest achievement in this line. In war time the unit construction idea took possession of bridge making also. What are called Hamilton bridges are of a standardised type and they can work somewhat like a meccano. The bridge may be large or small, but parts are interchangeable. Such standarised work as Hamilton bridges is not economical in peace-time nor is it economical in war-time either, but the needs of the war called for it and therefore it had to be made.

The amount of steel going to bridges has greatly increased. as will be clear from the following tables:—

Year	Steel used for bridges (Tons)	Value Rs.
1940	1,381	3,90,873
1941	10,365	19,95,141
1942	11,515	67,77,049
1943	21,823	1,17,92,294

The estimates for 1944 are even higher.

Floating docks.

Ship building is not legitimately a part of structural engin eering but in war time it has become necessary for structural firms to take a hand in marine engineering also. Thus in the U. S. A., the firm of Kaisar has been engaged in shipbuilding lately on a pre-fabrication basis. Our engineering firms have not gone so far, but in India also barges are being made by them. They have gone further, and have made large floating docks. For this purpose, Messrs. Braithwaites, Burns and Jessops have joined together into a combined concern (B.B.J.) for the convenience of operation. Three such docks have been constructed, and one of them is said to be the largest in the world. Ferry pontoons and DTN Flats have also been made.

Steel Consumption.—In pre-war day's about 60,000 tons of mild and high tensile steel, rivets and bolts were annually used by the structural industry. Since the outbreak of war, the consumption has steadily increased and should now be about double. The bulk of the output now goes into Defence requirements (Naval, Military and Air Force) and into the essential key industries like iron and steel works, ports, etc.

Localisation of the Industry.

From the first, structural industry was concentrated in and around Calcutta, and in the vicinity of the two big steel factories. The nearness of the port of

Calcutta and the availability of iron ore, coal, limestone, etc., have been the principal factors leading to such a localisation. A list of 32 firms engaged in Civilian Engineering Works is given below. It will be seen from it that the bulk of the structural fabricating industry (representing approximately 75 per cent. of the total output) is located in the Provinces of Bengal and Bihar.

List of Structural Engineering Firms.

Calcutta area:

Jas. Alexander & Co., Ltd.
Beruck & Comens Ltd.
Braithwaite & Co. (India) Ltd.
B. B. J. Cons. Co. Ltd. (Victoria Works).
Bridge & Roof Co. (India) Ltd.
Britannia Bldg. & Iron Co. Ltd.
Burn & Co. Ltd.
Arthur Butler & Co. (Muzz) Ltd.
Howrah Engineering Co.
Jessop & Co., Ltd.
Kumardhubi Engineering Works Ltd.
Mackintosh Burn Ltd.
A. & J. Main & Co., Ltd.
Martin & Co. (Structural).
Saran Engineering Co., Cawnpore.
Steel Equipment & Cons. Co, Ltd.
Kushmika Iron Works.
Singh Engineering Co. (Cawnpore).
India Standard Wagon Co.

Bombay area:

Alcock Ashdown & Co, Ltd.
Richardson & Cruddas.
Structural Engineering Works Ltd
Garlick & Co.

Karachi area:

Herman & Mohatta Ltd.
Carstairs & Cumming.
Dock Welding & Engineering Works.
Alcock Ashdown & Co., Ltd. (Karachi).

Madras area:

Richardson & Cruddas
Chitram & Co.
Biony & Co. (Madras) Ltd.

South India area:

Harrisons & Crosfield Ltd. (Quilon).
Mysore Iron & Steel Works.

Nature of Machinery Used.—In the bigger fabricating shops the usual structural fabricating machines are installed; these are punch and croppers, splitting and guillotine shears, cold mangles, angle and joist straighteners, high speed radial drills, pneumatic and hydraulic rivetting machines, hydraulic presses, electric are welding machines, and the shops in which these machines are installed are serviced by hydraulic pneumatic mains, overhead electric cranes, etc.

Some of the smaller machine tools are now made in India but the bigger ones have hitherto been imported from abroad, *e.g.*, guillotine shears, hydraulic rivetting machines, cold place mangles, croppers, splitting shears, etc.

Raw Materials.—The structural fabricating industry uses indigenous sections, plates, bars of steel, of mild and high tensile qualities, bolts and nuts, rivets, iron and steel castings, galvanised sheet work, electrodes, paint, etc. All except the special high quality electrodes are produced in this country, but with regard to steel, special wide plates and sections, beyond the capacity of Indian rolling mills, are imported.

War Time Expansion.

It is believed that before the war only 50 per cent. of the capacity of India's Structural Industry was absorbed. The capacity has increased in war time conditions, and is believed to be about 10,000 tons per month, but hitherto it has not been able to reach this output due to inadequate supplies of materials, transport, trained labour, etc. The estimates for 1944 are fairly large.

Thus although production has increased in war time due to the enhanced demand for fabricated structures, the full capacity of the Structural Engineering Industry in India has not over a period been absorbed for various reasons beyond the control of fabricators themselves. The increased output required as a result of war demands has been met by working on a more continuous basis, and in several cases night shifts have been worked for the last two or three years.

Some existing fabricating shops were able to obtain in the early years of the war, certain items of machine-tools and these they installed to assist in balancing their output, but the amount of new machinery installed in fabricating shops since the beginning of the war has not made very much difference to the production capacity.

Labour.—With regard to skilled labour, there never was a surplus in pre-war days and most workshops train their own labour. When skilled engineering labour was required for industries other than the engineering industry, a certain amount of skilled labour left Civil Engineering Workshops and these were replaced by newly trained men. Ever since the beginning of the war, Engineering Workshops have had to continue training men to fill the gaps caused by skilled and semi-skilled labour leaving for more remunerative jobs offered by Military and Government projects.

Post-war Adjustments.

Prior to the outbreak of war, the structural engineering industry had a struggle to keep establishments going, due to the paucity of demand. Such demands for structural work as there were emanated mainly from the Railways and Public Works Departments and only a small proportion of the demands emanated from industries. Whether the structural industry can compete successfully with imports in the open market after the war depends largely on the price of steel and the regulation of any dumping of foreign steel manufactures into India after the war at uneconomic prices. The structural industry will have a large part to play if industrialization is accelerated in the post-war period. A reconstruction programme comprising road, rail and bridges, port expansion and railway developments will also benefit the industry. The Rs. 400 crores road programme sets apart Rs. 50 crores for bridges, and this alone could give a fillip to the structural industry, if properly carried out.

Disposals.—An important question for immediate concern is the disposal of the surplus military buildings after the cessation of hostilities. If many thousands of tons of standard buildings of the T. G. type, Twin Nissen Huts, etc. are suddenly thrown on the market at scrap prices, it may have unfavourable repercussions on the steel industry and the structural industry as well. Hence the need for very carefully regulating the disposal of such articles A planned policy of public works, especially house-building and town planning, will greatly help in the orderly disposal of all surplus materials. Pre-fabrication of houses may also be considered with a view to using up our surplus steel making and fabricating capacity—if any—after the war.

SECTION VI. WAGON BUILDING AND ARMOURED VEHICLES

General. Of the many articles which the Indian engineering industry was called upon to manufacture in war time, wagons and armoured fighting vehicles stand out. Their manufacture involves both structural and mechanical processes. Therefore they may be dealt with here before passing on to other branches of engineering.

1. Wagon Building

Before the war

The building of Railway wagons in India is a long established industry. The Railway Companies have their own equipment for repairing and reconditioning wagons but they do not ordinarily construct new wagons. Wagon building involves both structural and mechanical processess, but it is not within the scope of those two industries. Nor is it one of those job works which an ordinary engineering firm could undertake with a general lay-out. It is a separate industry by itself, and requires a workshop, special lay-out etc.

Four firms in India have been making wagons, three of them for a pretty long time. These are :—

Jessop & Co. (Dum Dum).
Bird & Co. (Howrah).
The Indian Standard Wagon Co. (Burnpur) and
Braithwaite & Co. (Kidderpore).

Of this, only the Indian Standard Wagon Co. specialises in wagon building, while the other firms deal with it along with other engineering works. Jessops have been building wagons for the last forty years, in a separate workshop, by

the side of its structural and mechanical workshop. The Indian Standard Wagon Co. is located in Burnpur, because of its connection with the Steel Corporation of Bengal (SCOB).

The four-wagon building firms named above had been turning out prior to the war, on an average, between 2,500 and 3,000 wagons a year. They had a capacity for double that number and perhaps there was also need for more wagons to be built. We shall not here enter into this controversial question regarding the policy of the Railway Board in the thirties.

In war-time

So long as imports continued unimpeded, there was no special difficulty experienced in obtaining components from the U. K. But after the middle of 1941, importation become difficult, and the Supply Department looked to local industry for the various materials required for wagon-building.

The following groups of material are required for the construction of wagons :—

(1) Controlled steel materials, like structurals, plates, bars and billets, spring steel and rivets.
(2) Steel castings and forgings.
(3) Wheels and axles.

The controlled items mentioned in (1) above, are made chiefly by the larger iron and steel producers. These are controlled by Government in the interests of co-ordination and rationalisation. The chief problem under (1) is regarding rivets. These have always been in short supply and were largely imported before the war. Imports being inadequate, production had to be undertaken here from rolled steel bars. This was taken up by Guest, Keen, Williams, Calcutta. They had been doing this work before, but it has now to be in a greatly extended scale, and they found it difficult to cope with it. In 1943, Burn & Co. and Jessop & Co. began to make their own rivets. In spite of such advances, a large quantity of rivets has still to be imported.

Castings and forgings —Steel castings are required for axle boxes, buffers, etc., and these are made by Kumardhubi Engineering Works, Bhartyia Electric Steel Co., Ballygunge and Burn & Co., Howrah. The wagon building firms place their orders directly with the firms just mentioned according to Supply Department's instructions, drawn up on the basis of the capacity of each firm.

Drawbar hooks, screw couplings, break gear, etc., are made from forgings. Steel is forget from billets. Billets are made from blooms which are made by pressing and lengthening out ingots. By forging with a steam hammer, billets are shaped into drawbar hooks, etc. Heavy forging is only done by Indian Standard Wagon Co., which, therefore, do this kind of work for all the wagon builders. Light forgings are made by Jessop & Co., Burn & Co. and by Britannia Engineering Co., Titaghur.

Wheels and axles.—These were formerly all imported, but two yaars ago Tatas succeeded in making them by laying out a new plant. Axles are forged by them with a heavy hammer. They are then machined. After machining, wheels are pressed on the axles forced on by hydraulic pressure. They are then dispatched to the wagon builders, who assemble the wagons. Tatas cannot cope with all the requirements, and a large quantity of wheels and axles are still imported.

The assembling process consists of the following :—First they rivet together the under-frame consisting mainly of channel members. Then they lower it on to wheels and axles. Then the body is built and finally it is painted. With the carrying out of the vacuum test, the wagon is completed.

Nature of the contract.—The contract for wagon building is between the Railway Board and the wagon building firms. The Supply Department only co-ordinates the orders under a plan. This is required because firstly most of the raw-materials are controlled and their supplies have to be regulated by Government, having regard to the best interests of Defence. Secondly without such

co-ordination the whole capacity may not be fully utilized. Some firms may get too many orders whereas others many have too few.

Wagon building programme.—A programme for 10,000 wagons was made in the middle of 1942 to be completed by the middle of 1944. Of this only about 1,800 wagons have been delivered so far (June 1944), the delay being largely due to the inadequate supply of wheels and axles. In spite of the active efforts of Government, and the India Supply Mission, imports could not be arranged in time. As has been shown above, the production of wheels and axles is now being undertaken at the Tata Iron & Steel Works, Jamshedpur, but the supply so far has not been adequate. Only by building about 800 wagons a month could the Defence demand be met, but so far it has been possible to make only 400 wagons in spite of the most active efforts. Therefore, we have to depend partly on imports. Arrangements have lately been made for the importation of a large number of wagons.

In the meantime the Railway Board has placed a fresh order for another 10,000 wagons. It remains to be seen how this fresh order along with arrears of the previous order could be carried out within the time fixed.

The future policy in regard to wagon building is one of great importance not only from the point of view of the Railways, but also of the steel and engineering industries in the country.

2. Armoured Vehicles

On the outbreak of war, India was found whitout any facilities for the manufacture of armoured vehicles, which are an essential part in mechanized warfare. Measures were soon taken to develop this industry. The chassis for the vehicles had to be imported from abroad, but the body could be designed and manufactured locally. This necessitated the development of the manufacture of bullet-proof steel, according to War Office specifieation. As explained in Chapter I, the Tata Works at Jamshedpur succeeded in making bullet-proof plating which came up to the specifications required. As the quantities produced were not adequate, imports had to be made from America. The next problem was the fabrication of the bullet-proof steel. This entailed the import of the oxy-acetylene cutting plant, which is the most economic and expeditious method of fabricating the bullet-proof steel into the required forms and sizes of plates. This oxy-cutting process was not unknown to India before the war, but latterly with the import of the latest types of machines, developed in other countries for cutting the plate the use of this process has made tremendous progress in this country. The remaining part of the manufacture of bodies, could be done by the engineering workshops in India.

The major portion of the armoured vehicle construction is undertaken at the East Indian Railway Workshops, Tatanagar, and to a lesser extent at the Bengal and Assam Railway Workshops, Kanchrapara, Indian Standard Wagon Co., Burnpur and the Port Commissioner's Works, Calcutta. These works undertake the fabrication of bullet-proof steel and the final construction of the vehicle including the major portion of the details required to be manufactured. In addition to these works, there are about 150 to 200 minor contracting firms employed from time to time under contractual arrangements for the manufacture of other components, which are supplied to the main producers for completing the vehicles. These components include.

(1) Pannier boxes.
(2) Rifle brackets and clips.
(3) Machine gun brackets and clips.
(4) Water tanks.
(5) Hot food containers.
(6) Sand mat brackets.
(7) Equipment lockers.
(8) Ammunition boxes.

From the outbreak of the war till 1944 March, 4,341 armoured vehicles and 1,132 un-armoured all-steel vehicles have been manufactured in India. The details of production are as follows :—

Items	1939-40.	1940-41.	1941-42.	1942-43.	1943-44
(1) Armoured carriers . .	Nil	10	1,239	2,039	1,091
(2) Unarmoured F. A. Tractors	,,	Nil	318	302	Nil
(3) Armoured trucks . .	,,	,,	52	116	Nil
(4) Unarmoured 220 gallon water tank lorries . .	,,	,,	40	20	Nil
(5) Unarmoured anti-tank lorries	,,	,,	12	Nil	Nil
(6) Armoured cars . . .	,,	,,	Nil	202	74
(7) Armoured ambulances .	,,	,,	,,	Nil	167

In the East Indian Railway Workshops which are the principal manufacturers, production has been greatly speeded up, and labourers are working in shifts for 20 hours of the day. The labour force increased from 500 in the pre-war period to 1,500 in the war period. The technical staff is manned by people from the different parts of India, and most of them are Matriculates. It has been found there that educated youngmen could pick up the technique of production more easily than the illiterate. They are taken on at the start as 'helpers', corresponding to 'mates' in England, and they get an initial wage rate of 10 annas per day, with prospects of getting higher pay according to the level of efficiency attained.

In addition to the manufacture of new armoured vehicles, maintenance spare parts and equipment for the maintenance of vehicles are also manufactured in India. The maintenance spare parts constitute spare parts for the body work only and do not cover precision spare parts for the engines and chassis. Spare parts for the bodies were being manufactured in India before the war. In war-time their supply has increased. They are mostly made by small firms working under contractual arrangement. Equipment for the maintenance of vehicles was also being made in India before the war. Their production has now increased with the increase in the production of completed vehicles. The following articles come under this category :—

(1) Foot pumps,
(2) Lifting Jacks,
(3) Wheel alignment gauges,
(4) Grease guns,
(5) Oil squirts,
(6) Lubricating equipment.

Post-war

It is difficult to say how far the experience gained in the manufacture of armoured vehicles would be valuable after the war, since they are essentially war stores. However, it has been established that heavy steel bodies for vehicles can be manufactured in India. Similarly, in the matter of maintenance spare parts and equipment for maintenance, India can hope to depend on her own manufacture in the post-war period, except for the precision parts required for the power unit and chassis. The technical experience gained can doubtless be put to wider industrial uses. Already men trained in the E. I. R. Workshops have been found suitable for a wide range of industrial operations and they will be of help in any industrial programmes to be launched after the war.

SECTION VII.—ELECTRICAL ENGINEERING

General—India's limited supplies of coal and oil make the development of electric power a matter of great importance not only because it is a cheap motive power for industries, but also because electricity is an essential requisite for raising the standard of living of the people. The use of electricity as a motive power for industries is bound to increase considerably in future. Increasing use of electricity will be required for transport purposes, especially the electrification of railways and the extended use of trams. The use of electricity for heating, lighting and cooling (by means of fans, refrigerators and air-conditioning apparatus) is also daily increasing. The enquiries of the Geological Survey of India have shown that India has fairly large sources of water power which could be used for generating

electricity at low costs. The potential reserves are estimated at about 27 million kilowats of which hardly half a million have been developed so far. With the larger utilization of electricity, the demand for the various accessories of electrical engineering will greatly increase and their manufacture in India may become necessary.

Before the war, India was producing some of the important electrical goods like incandescent electrical lamps, electric fans, etc., but Indian production could meet only a small portion of the internal demand. Imports came chiefly from the U. K. (50 per cent in the case of the lamps, 60 per cent of the fans and 90 per cent. of the secondary batteries). Germany came next in the list followed by the Netherlands, Italy and France. Imports from Japan were meagre except in the case of vacuum lamps, 70 per cent, of which came from that country. The U. S. A. came in only for a small share of such imports.

War has brought an opportunity for the expansion of these industries and for the starting of the production of new items. The following are the most important electrical accessories whose production has been newly started in India as a result of the war :—

(1) Black Adhesive tapes.
(2) Conduit Pipes.
(3) 'D' class signalling cable.

As a result of the war demand, the production of the following articles has received a great fililp :—

(1) Electric Fans.
(2) Incandescent electric lamps.
(3) Accessories for electric lighting.
(4) Dry batteries and cells.
(5) Secondary battteries.
(6) Distribution transformers.
(7) Electric wires and cables.
(8) Electric motors.

The production of all these articles except electric fans and incandescent electric lamps was on a very small scale before the war, and the expansion of their production has been considerable especially in the cause of electric wires and cables, electric motors, etc.

The components and raw materials for these industries had to come from abroad before the war, excepting for some of the minor items like bare copper wire and cable, red lead, antimony, etc. The position has not improved much in war-time, though efforts are being made to find substitutes indigenously for many of the component parts : e.g., mild steel sheets in the place of aluminium for fan blades, plan bearings in the place of ball bearings, etc. But such indigenous materials can not be depended upon for production for a competitive market, where good quality and low costs are the deciding factors. The shortage of raw materials and component parts have held up the progress of many of these industries in war-time : e.g,, the production figures of electric fans fell from 517,400 in 1941 to 49,400 in 1942. Similarly in the case sf the accessories for electric lighting. the plants of 3 firms are remaining idle due to lack of supply of bakelite powder and other raw materials. In the case of incandescent lamps, however, 2 important component parts, namely glass shells and brass caps, are now manufactured here, and Government have had a large part to play in developlng the production of these two articles.

1. Incandescent Electric Lamps for General Lighting Services

Pre-war

This heading excludes lamps for automobiles and torches and also special types of lamps required for projectors, studios etc., and refers to electric bulbs used for lighting of factories, workshops, mills and residential buildings. Annualy India was consuming nearly 14 million of such complete gas-filled and vacuum electric lamps. Of this about 11 million came from overseas. Nearly 50 per cent. of imported gas filled electric bulbs came from U. K. about 20 per cent. from the Netherlands and 15 per cent. from Japan. The rest came from other Continental countries. In the case of vacuum electric bulbs, nearly 70 per cent. of imports came from Japan and the rest from Europe and America. Though the Japanese lamps were of inferior quality and hence were

not accepted by the Government Departments, they were very popular in the civilian market due to their low prices. The balance of India's total annual consumption (about 3 million bulb) was being produced by firms in India. But theirs wos only a work of assembling component parts imported. Of the total trade, the requirements of the Government came to about 5 per cent.

War-time

With the outbreak of war and with the break with Japan, imports from the Continent and Japan stopped and those from U.K. and U.S.A. necessarily diminished. On the other hand there was a huge increase in the demand from factories, mills and other industries engaged in war work, in addition to the large requirements of the Defence Services. All this has led to a great expansion of production in the Indian factories. In some of the small factories, this new demand has resulted in an expansion of the personnel and some essential plants, while in the bigger ones it has meant production to the full of the already existing capacity of plant and personnel.

The production figures for later war years, as compared with the average pre-war figures, and the Government purchases in each of those years are given in the following table.

Year	Total Production. (Quantity).	Government Purchases. Quantity.	Value. Rs.
Pre-war	2¾ millions	7,00,000	5,85,000
1942	3¾ millions	14,69,359	12,98,492
1943	3¾ millions	11,60,001	10,61,314
1944 (Estimated)	5 millions	28,74,000	27,98,475

It is clear from this table that the war-time production is only one-third of the total peace-time consumption of India, not to speak of its insufficiency to meet the inflated war-time demands. In fact total Indian demand for 1944 is estimated to come to about 18 million. Thus our depandence on imports has only increased in war-time even with the expanded Indian production. Imports are coming now from U.K. and U.S.A.; of late the share of U.S.A. has been rising. But even with the imports the total supply of lamps in India is far below the actual needs, and hence the civilian market is starved to a very great extent.

The following firms are manufacturing the lamps, and they are listed in the order of their volume of output.

1. Electric Lamp Manufacturers of India Ltd., Calcutta.
2. Bengal Electrical Lamp Works Ltd,, Calcutta.
3. Radio Lamp Works Ltd., Karachi.
4. Mysore Lamp Works Ltd., Bangalore.
5. Kaycee Industries Ltd., Shikohabad.
6. Lux Lamps Ltd., Culcutta.
7. Bharat Electrical Bulb Works Ltd., Calcutta.
8. Calcutta Electrical Lamp Works Ltd., Calcutta.
9. Asia Electrical Lamp Works Ltd., Calcutta.
10. Bijlee Products Ltd., Bombay.

The first of these, namely Electric Lamp Manufacturers of India Ltd., manufactures lamps and brand them according to the requirements of its various partner firms, who are the leading European concerns in India dealing in lamps. They are the following:

1. Associated Electrical Industries (India) Ltd.
2. General Electric Company (India) Ltd.
3. Philips Electrical Company (India) Ltd.
4. F. & C. Osler Ltd.
5. Greaves Cotton and Crompton Parkinson Ltd.
6. Balmer Lawrie and Co., Ltd.
7. Siemens (India) Ltd.

Lux Lamps Ltd. and Kaycee Industries are new firms set up in war-time. All the machinery used by these firms are imported from aboard.

The statutory control exercised by the Government as a war-time measure over all these firms involves three things:

(1) The firms are required to be engaged solely in the production and manufacture of electric lamps under the direction of the Director General of Munitions Production or an officer authorised by him and comply with all instructions issued from time to time by the D.G.M.P. or the Officer authorised by him, in respect of the production and manufacture of electric lamps of any size, wattage or voltage

(2) On the 20th of every month a complete statement of the estimated production during the following month and of their dispatches during the previous month of electric lamps is to be submitted to the D.G.M.P., or the Officer authorised by him.

(3) The firms are prohibited from selling or consuming or disposing of otherwise any electric lamp except under the written authorisation from the said Officer.

Before the war India was depending on imports for all the raw materials and component parts of electric lamps. They are glass shells, tungsten filament, lead-in-wire, molybdenum wire, caps, and gases like nitrogen and argon. Some attempts were made to use Indian made glass, but it was found unsuitable. Japanese glass was also not uniform and satisfactory, though some imported from U. K., Germany and Japan, though it was possible to make them locally with the exception of black glass. Before the war Bengal Lamp Works were planning to instal a glass furnace to manufacture black glass, but this scheme did not materialise. Tungsten filament, lead-in-wire and molybdenum wire were being imported from U. K., Germany, Holland, U.S.A. and Japan. Nitrogen gas was also imported, since it was not produced in India. The Lightfoot Refrigerator Company of Calcutta could save the nitrogen that was being wasted in their manufacture of oxygen, but no attempt was made in this direction since the quantity that could thus be obtained is small. Argon gas is required only in small quantities and was not obtained in India. These two gases came from U. K.

The wholesale dependence on imported component parts has not materially changed for the better in war-time, even though their supply from the Continent and Japan was cut off. The only notable improvement is the manufacture in India of glass shells. With the help of the Government the glass shell blowing industry has been able to produce satisfactory types of glass shell for electric lamps. This work is now done by several small firms in and around Calcutta and by the big factory of the Kaycee Glass Industries at Shikohabad in U. P. Similarly brass caps (complete with black glass) are now produced in India by the Radio Lamp Works, Karachi. Excepting for these items, all the raw materials are still being imported from U. K. and U. S. A. Even after the war, India cannot hope to develop local supplies of any of these raw materials, excepting perhaps copper and nickle wires which could be made here, provided there is an indigenous supply of electrolytic copper and nickel, and a welding machine is installed.

Though the industry is only one of assembling imported component parts, it calls for highly skilled labour. The glass blowing industry also requires skill of a very high order. Labourers of the required standard of skill for all the operations have been trained in India, and are found efficient in the work.

2. Electric Fans

Before the War

Before the war the great majority of fans and their parts used in India was imported. In 1936-37, electric fans and parts thereof worth over Rs. 35 lakhs were imported. But in 1938-39, the figure came only to about Rs. 25 lakhs. More than half of the imports came from U. K.; the other importing countries were Germany, Italy, U.S.A. and Japan, the share of the last two

being very small. Production of fans in India was confined to 7 firms mentioned below.

(1) India Electric Works Ltd. Calcutta.
(2) Calcutta Electrical Manufacturing Co., Calcutta.
(3) Electric Fan and Motor Manufacturing Co., Lahore.
(4) Model Industries, Dayalbagh.
(5) British India Electric Construction Co., Calcutta
(6) Everest Engineering Co,, Calcutta.
(7) Greaves Cotton & Crompton Parkinson, Bombay.

Of the above firms, the India Electric Works was the first in India to take up the production of fans and this still remains the biggest producer in India. It bought up the patent rights of a fan designed by an Indian engineer, Mr. Bhattacharya, and began production in 1924. The other producers came into the field in the thirties.

In War-time

In War-time, there has been greater demand for fans and shrinkage in imports. (In 1940 41, imports came only to Rs. 14 lakhs). Indian production has hence gone up, though not sufficiently enough to meet the demand in full. This has led to strict rationing being introduced in supplying fans to civilian and other non-essential demands, so as to meet the increased Defence demands, and also face the considerably reduced imports of raw materials. Existing factories, with the exception of India Electric Works were not in a position to increase production very much owing to shortage of raw materials. This Company however had large stocks of raw materials and was therefore able to expand their works at Behala, a suburb of Calcutta. At the same time many new companies took advantage of the high war-time prices of fans, and started small concerns; many of them have since grown into fair-sized industrial unit. The new firms are the following:—

(1) Clyde Fan Co., Calcutta.
(2) Kaycee Industries, Calcutta and Lahore.
(3) Oriental Mercantile Co., Calcutta.
(4) G. T. R. & Co., Calcutta.
(5) Metropole Works, Amritsar.
(6) Swastika Electric Works, Calcutta.
(7) Raghu Engineering Works, Delhi.

The machinery installed in the big factories are mostly imported. Since the fan industry is not of a specialised kind, the small concerns newly started got the necessary machinery from some other industrial concerns or from indigenous manufacture. The India Electric Works obtained additional machinery for its factory at Behala from foreign countries like U K., U. S. A, etc. Some lathes were imported from China also.

Skilled labour is of great importance in this industry. The India Electric Works had trained a large number of hands and new companies were able to employ them. The India Electric Works now employ about 1,000 people at its Behala factory and about 600 at its Entally factory; the latter establishment is at present exclusively engaged in the manufacture of telephone and telegraph instruments, Railway signalling and interlocking instruments and other scientific instruments required by the various departments of the Government, principally for war purposes.

Production.—Pre-war production of fans in India came to about 30,000 ceiling fans and 5,000 table fans, on a very rough estimation. The table fans were produced only by the India Electric Works and the position has not changed in war time. The production figures during war years are as follows:

Year	Ceiling Fans	Table Fans
1940	38,000	6,800
1941	47,800	9,600
1942	38,400	11,000
1943	41,200	10,000
1944 (Planned)	105,000	30,000

The fall in production in 1942-43 of ceiling and table fans was due to the lack of imported raw materials. Planned production figures for 1944 are what the firms claim as their productive capacity for the year, provided they get the required quantity of raw materials. But these figures appear to be too ambitious in view of the fact that the supply of the raw materials is unlikely to be available in full. Hence it is safer to state that the actual production is likely to be in the neighbourhood of 60,000 ceiling fans and 12,000 table fans.

Of the total production in 1943, the share of each of the big firms is as follows:—

	Ceiling fans.	Table fans
India Electric Works	12,000	8,900
Calcutta Electric Manufacturing Co.	6,499	Nil
Electric Fan Manufacturing Co.	4,161	Nil
Greaves Cotton and Crompton Parkinson . . .	11,400	Nil
Total .	41,060	8,900

The balance of the production of the year mentioned above was made up by the other small firms. In addition to ceiling fans (A.C., D.C.) and table fans (A.C., D.C.), special types of fans are also being manufactured in India such as exhaust fans, railway carriage fans and cabin type fans used in the ships. But the number of such fans produced here is not great.

Raw Materials.—Most of the raw materials for fan manufacture were obtained by importation before the war. Chief of them are the following :

Stampings.—(Special types of insulated steel sheets with high silicon contents). These are particularly required for A.C. fans and are imported from U K. and U.S.A. The new stamping plant at Bombay is planning to produce silicon sheets, but original silicon sheets have to be imported. For the manufacture of D.C. fans, ordinary Tata black sheets are now being used with satisfactory results.

Winding wires of various types and sizes.—Enamelled and silk covered copper wires are not manufactured in India and have so far been imported from U. K. and U. S. A. The Indian Cable Co. however, can make covered copper wires which may be used by D.C. fan manufacturers, but its use has not been found very satisfactory.

Nichrome Resistance wire.—It is imported even now.

Ball Bearings.—Indian fan manufacturers unlike American fan manufacturers, use ball bearings for easy propelling of fans. India has been completely dependent on foreign imports for such ball bearings. But now due to acute shortage of ball bearings, particularly of the types required in the manufacture of æroplanes, torpedoes etc., Indian industries have been compelled to use plain bearings, instead. But its adoption is hampered to a certain extent by the difficulty of procuring certain small tools such as Reamers etc,, essentially needed for the manufacture of these types of sleeve bearings.

Insulating materials, such as leatheroid empire cloth, tape and tubings, ebonite rod, bakelite sheets etc.—All these items are imported. Attempts however have been made recently to use Indian substitutes for these insulating materials, but climatic conditions in India compel the fan manufacturers to use the genuine stuff. The Indian Electric Works attempted to produce empire cloth for which they have designed and made some of the machinery required, but due to the lack of some essential chemicals progress is very slow. This Company is making experiments for the production of carbon brushes, leatheriods etc.

Aluminium sheets.—These are mainly required for fan blades. The metal is imported and fabricated into sheets here by the aluminium factories. Upto 1926 the India Electric Works which was the only producer of fans in India then, was making all their fans with steel blades. This practice has been revived in war time owing to the scarcity of aluminium, and attempts are being made to use other substitute materials also. Mild steel sheets have been used with fairly satisfactory results but due to the light and malleable

nature of aluminium, its use is preferred. Table fans require cold rolled brass sheets, and before the war the Indian manufacturers were importing it from Europe, principally from Germany. Attempts were made in 1932 to use Indian rolled sheets instead. The Indian Copper Corporation managed by Gillanders Arbuthnot was the only firm in India rolling sheets, but their rolling was for ordinary purposes and therefore the sheets were not evenly rolled. This was the case with the brass sheets available in the Indian market coming from other sources also. Uneven rolling leads to varying distribution of weight on the blades. After the outbreak of the war experiments are being made to find rolled brass sheets locally. Blades for railway carriage fans are made from mild steel sheets.

Pipes for down rods are also imported.

From the above survey it can be seen that the dependence on imports for the essential raw materials for fan manufacture continues even in war time.

Since 1942, Government has begun assisting the industry by supplying the manufacturers with essential raw materials, imported mostly from U.S.A. under Lease/Lend, and partly from U.K. Actually, although the materials from U.S.A. were indented as far back as August 1942, supplies have started coming early this year only. This has been the real reason for the fall in fan production during 1942-43. The production of the manufacturers who are supplied with raw materials is controlled by the Government. But until recently many manufacturers were producing fans with raw materials obtained from the black market and selling them to the public at exorbitant prices. But the percentage of production of such manufacturers could not have been more than 10 per cent of the total production.

Post-war

The present production may meet in full the peace-time demands of India. Well-established firms like India Electric Works, Calcutta Electric Manufacturing Company and Crompton Parkinson, who are able to produce fans of standard quality may hold their own even after the war, but the newer firms may find it too hard to compete with imports, unless special protection is given.

As the Indian industry is handicapped by its dependence on imports for some of the essential components and raw materials, suggestions have been made by certain businessmen that the Government should set up a pilotplant at its own expense to draw very fine insulated double silk covered and enamelled copper wire, as this is required not only for the fan industry but also for motor and scientific instrument industries. If this is not possible, they say, the Government should at least persuade the existing cable companies in India to provide this facility to fan manufacturing industry, by getting the necessary machinery for manufacturing fine wires of sizes 20 and 40 S.W.G. and encourage new cable companies to take up this line of production. The practicability of this will have to be enquired into.

In the matter of ball bearings also, it is suggested by certain businessmen that a Government plant to manufacture ball bearings and their fittings would be a great boon to Indian industries. Ball bearings are required not only for the fans but also for automobiles, cycles etc., and therefore this is a commodity for which a great demand may arise. Although the elaborate precision tools and the highly skilled labour required will not be available in India, the special hard alloy steel needed may be made here, thanks to recent advances in alloy steel making. But it is doubtful if, in spite of the various lines of demand, there will be ample room for the new industry in India, seeing that any economic ball bearing manufacturing unit would produce India's total annual requirements of bearings within a week. India's total requirements of ball bearings amount to only about 400,000 a year, and these comprise 2,500 different varieties.

Accessories for electric lighting

These include Tumbler switches plain, Tumbler switches with fuses for train lighting, Tumbler switches single pole, oen way with incorporated fuses,

ceiling roses, plugs, wall sockets, cut outs, lamp-holders, etc. The materials from which most of these articles are made are bakelite, copper and brass.

Before the war, there were a few firms in India making some or all of these accessories, chief of whom were Key Engineering Co. Lahore, India Moulding Co., Calcutta., Bake O' Brass Ltd., Bombay, Government Electric Factory, Bangalore, Bengal Potteries, Calcutta and Swedeshi Industries, Calcutta. But on the outbreak of this war some of these firms were not producing. In the war years, 4 more firms have set up plants for the production of the accessories, namely, Plastic Products, Cawnpore, Hind Cycles, Bombay, Besto Light, Bombay and India Electric Works, Calcutta. The last three are not producing now, as sufficient quantity of bakelite powder and other raw materials are not available. The Supply Department gets its requirements from the Kay Engineering Works, Lahore. Swadeshi Industries, Calcutta, India Moulding Co., Calcutta and Plastic Products, Cawnpore.

Before the war, India was also importing these accessories in large quantities. In 1938-39, the value of imports came to Rs. 6,95,086. More than 50 per cent. of imports came from U. K., about 25 per cent. from Germany and the rest from France, Austria, Japan and U. S. A. Compared to imports the Indian products were at a disadvantage because the indispensable raw materials were subjcet to a 25 per cent. import duty. Hence a similar import duty on finished goods did not benefit Indian industries to any great extent.

Attempts were being made to find substitutes for the Bakelite Powder. Even before the war, the Indian Lac Research Institute, Ranchi, was experimenting with Shellac ingredients for use in place of Bakelite Powder. These experiments have not proved highly successful. Though accessories made of Shellac Powder are now being made, their production is not on a commercial scale, nor are they in accordance with the British Standard Specifications. Brass and Copper are also imported, as the Indian manufactured quality is not up to the mark. Kay Engineering Co., however, makes its own copper and brass screws, strips etc. To the other firms also indigenous samples are being provided according to the specifications of the imported quality, and the firms are asked to report on the same. It is likely that Indian firms shall eventually be able to produce non-ferrous metals acceptable to this industry. Mild steel and wire are available from Indian production. Spring steel wire has got to be imported and certain sections of Brass rods, which are not yet being manufactured in India, will also have to be imported.

The machinery required for the manufacture of electrical accessories include Hydraulic presses, Capstan Lathes. Bench Drilling Machines, Screw cutting and Thread Rolling Plant and Tableting machines. Moulding is done on hydraulic presses. All the machinery is imported. India can however, now make the capstan lathes and drilling machines, even though they are not as good as the imported ones.

The production figures of the Indian firms in 1943 were as follows:—

	Articles	Total quantity
1.	Tumbler switches S. P. one way 5 amps	48,000 Doz.
2.	Celling roses, 2 plate. 5 amps	50,000 ,,
3.	Plugs 2 pins 5 amps.	18,000 ,,
4.	Sockets 2 pins 5 amps	18 000 ,,
5.	Cut outs 5 amps	72,000 ,,
6.	Lampholders, Bayonetcap cordgrip	24,000 ,,
7.	Tumbler switches, S. P. one way with incorporated fuses	4,800 ,,
8.	5 amps. switch plug combination.	1,000 ,,

In 1944 the production is expected to be higher, especially after the indigenous supply of brass and copper becomes available, These production figures exclude the capacity of the plants available with India Electric Works. Besto Light and Hind Cycles, whose plants are remaining idle due to lack of supply of bakelite powder and other raw materials. Government is buying up the lion's share of Indian production. The only control exercised by the Government is through the issue of licenses necessary for importing raw materials.

It cannot be said with any amount of certainly, judging from the data available with the Electrical Directorate of the Supply Department, that the production of electrical accessories has increased in war time, in spite of the diminution in imports and abnormal war demands. The fact that more firms were producing these articles before the war and the fact that the supply of essential raw materials from abroad has now diminished considerably indicate that war-time production is less than the pre-war figures. The actual figures of production of some of the items, obtained from a reliable source, are much higher than the war-time figures given above. Perhaps this fall in production is due to the scarcity of improved raw materials.

At present there are considerable imports of electrical accessories from U. K. and U. S. A. The peace-time requirements of India for these articles can, however, be met in full, if all the plants now existing in India work to their full capacity. But keen competition of imports is certain. If so, Government may have to increase the tariff protection, since the present import duty on finished goods is almost the same as the import duty on the necessary raw materials.

4. Dry Batteries and Cells

Dry batteries and cells are of immense importance to a modern army which relies to an enormous extent on W / T in operations. The industry was in existence in India before the war, but there was a large import trade also, principally from U. S. A. Imports also came from Germany, Hongkong, U. K. and China. In 1936-37, Rs. 26 lakhs (approximately) worth of dry and inert batteries and cells were imported. Imports of batteries for flash lamps came to the value of about Rs 22 lakhs. Another Rs. 3 lakhs worth of other batteries were also imported in the same year.

Abnormal war demands and curtailed imports have led the expansion of the work of the two principal manufacturers In India, namely National Carbon Co. (India) Ltd., Calcutta, and Estrela Batteries Ltd., Bombay. The first firm is working a longer shift and the second is working 2 shifts. Estrela Batteries are now erecting a new factory at Bombay.

The two firms are under the statutory control of the Government, according to which the entire production is to be carried on under instructions from the D. G. M. P. and the disposal of the output is to be made under the written authorisation from the D. G. M. P. The firms are also required to submit to the D. G. M. P. on the 7th of every month a complete statement of their despatches during the previous month. In return, the firms are assisted by the Government in the matter of importing materials from U. S. A. under Lease / Lend and from U. K. and acquiring local materials most of which are controlled. Besides these, every other assistance is given by the Government from time to time in order to enable the firms to adhere to the monthly programme planned by the Supply Department.

The present production includes dry batteries and cells, inert cells and sac elements as used for military communications, air craft wireless equipment, field telephones, torches. testing apparatus etc. Of the raw materials and components required, carbon electrodes, acetylene lamp black, manganese dioxide, ammonium chloride, zinc chloride, mercuric chloride and zinc sheet and strips are imported, while card board, paper, wheat flour, corn starch, resin and asphalt are partly imported and partly obtained indigenously. Bare copper wire and cable alone are obtained entirely from local sources. All the essential machinery had been imported before the war, but modifications were made on the existing plant to produce special types of dry batteries and cells required by the Defence Services. Additional labour needed was trained locally.

The present indigenous production can meet the major portion of the post-war requirements of the commodity in India. A large number of the types of cells required by the Defence services is also in demand by the civilian trade,

and adjustments that may be necessary for the switch over from war to peace production should not offer any great difficulty.

As the products of both firms had been competing successfully with imports before the war, there appears to be no reason why they should not continue to do so on the termination of hostilities.

5. Secondary Batteries. (Electric Accumulators.)

There are two main types of electric accumulators, the lead-acid type and the alkaline type. The former type has plates oflead with an electrolyte of dilute sulphuric acid, while the latter type has plates of iron and nickel with potassium hydrate as the electrolyte. A recent development in the alkaline type is the nickel-cadmium cell which, owing to its relatively low internal resistance, finds use in automobiles. The voltage of a lead-acid cell varies from about 2·6 volts when fully charged to about 1·7 volts when discharged. The alkaline cell varies from about 1·5 volts to 1 volt or under, at the end of discharge. The normal voltages are 2 and 1·5 volts respectively. The smaller sizes of lead-acid accumulators are provided with a glass or moulded container. Larger sizes of stationary accumulators may have glass or lead-lined wooden containers, the largest sizes having wooden containers only. Lids, fitted with air-vents, are provided when necessary to prevent spilling. In the case of small accumulators, in order to reduce space, the multi-cell type of construction is usually adopted, a battery of several cells being purchased as one unit. The alkaline type has a steel container.

The largest user of electric accumulators is probably the motor car industry; the wireless industry has also been a larger user of the G-Volt motor car type batteries, but the increasing use of 'mains' sets, where electric supply is available, is tending to restrict the use of accumulators by this trade. Large stationary batteries of electric accumulators are being increasingly used by hospitals, cinemas, etc., to safeguard the supply of electricity in the event of a breakdown of the public supply. Before the war broke out, the Army Singal Service in India on a recommendation made by the Royal Engineer and Signal Board in London, decided to standardise on the lead-acid accumulator, and the Royal Air Force in India was considering a proposal to standardise on the alkaline type.

The greater portion of electric accumulators used in India before the war was imported.

The value of imports of accumulators and parts thereof and percentage of total imports received from each country are given in the following table. It can be seen therefrom that the imports have been falling off since 1931.

	1931-32	1937-38	1938-39
	Rs.	Rs.	Rs.
Value of Imports	8,54,768	7,05,920	6,95,086
Percentage share.—			
United Kingdom	72·1	90·2	89·7
Germany	0.6	6·5	5·3
France	8·2	less than 0·1	—
Belgium	14·2	—	—
United States	4·9	—	—
Switzerland	—	3·0	—

The above figures do not include the electric accumulators imported as part of the chassis of motor cars, cycles, lorries, etc. Their imports came to about Rs. 12,000 in 1931-32 and Rs. 32,000 in 1937-38, the principal importing countries being U. S. A., U. K. and Canada.

A few firms in India were producing lead-acid electric accumulators for the use of motor cars and one firm, namely Amco Ltd., Bangalore was also producing certain types of battery plates required for train lighting cells.

Most of the raw materials, namely lead refined, antimony, red lead lithrage, sulphuric acid, and sealing compound were obtained from indigenous sources. Some component parts like containers, cell lids, vent plugs and separators were imported from abroad. The entire process with the exception of the plate-forming, which is carried out electrically, is done by hand.

War brought a diminution in imports and rise in demand. But only one new firm has entered the field in war time, namely the Standard Batteries Ltd., Bombay. This and two other firms (Bharat Battery Manufacturing Co., Ltd., Calcutta and Estrela Batteries Ltd., Bombay) are under the statutory control of the Munitions Productions Branch of the Supply Department, which works in the same way as in the case of Dry batteries and cells. As Amco Ltd., is in the Mysore State, it could not be brought under the control, and all that exists is a gentleman's agreement between the Government and the firm. Another firm, the Chloride Electrical Storage Co., is putting up a new factory for the production of secondary Batteries. Government have been giving all assistance such as the supplying of raw materials, all of which are now obtainable from indigenous sources, and the releasing of additional equipment. Owing to the difficulty of getting them from abroad, mould and forming containers were made or purchased locally, as also was the case with lead burning equipment.

It is too early to say if the present production capacity of India could satisfy the entire post-war Indian demand, even taking into account the capacity of the new factory that is being put up by the Chloride Electrical Storage Co. Even if it could, it is to be expected that the competition of imports especially of the popular makes of batteries such as Exide and Delco which are produced on mass production lines will be too much for the Indian industries with their poor equipment and production by hand. Hence it is necessary that the existing factories should follow the example of the Chloride Electrical Storage Co., who are installing the very latest equipment in their new factory, and make their production methods up to date. Government can do much to help the firms in this direction.

6. Distribution Transformers

Distribution transformers of the Standard industrial type (excluding flameproof) upto 500 K.V.A. capacity and upto 11,000 volts on the H.T. side are required for use in every industry depending on electricity and for the various electricity supply undertakings.

The manufacture of the transformers existed in India before the war on a small scale. After the outbreak of war, it has expanded considerably due to abnormal war demands consequent on the expansion of ordnance factories, workshops, textile mills, etc., and also due to increased distribution of electrical energy for the new military establishment. Imports which came to the value of Rs. 25, 62, 716 in 1938-39, declined especially after 1940. In 1940-41 they came only to Rs. 19, 11, 763. The expansion of the industry was achieved by laying out new plant obtained from U. K. Skilled labour required was trained locally.

The principal raw materials and components used are Silicon steel stampings, cotton covered copper wires and strips, insulating materials and solid drawn steel tubing. Of these Silicon steel stampings were imported till the beginning of 1944, but the new stamping plant at Bombay is now supplying this article to the industry in part. The original silicon steel sheets have however to be imported, although in the case of the former some indigenous material is being tried by some of the factories. Thus the only articles locally made are cotton covered copper wires and strips.

The only producer before the war was the Government Electric Factory, Bangalore, which started production in 1936-37. After the outbreak of war two more firms began production. Associated Electrical Industries Manufacturing Co., Calcutta, which began production in 1941 and Crompton Parkinson Works, Bombay, starting production in 1943. Some of the machinery used by these firms are locally made, the rest being imported.

The two new firms are daughter institutions of two important English firms. Therefore a few of the skilled employees are non-Indians. The training of skilled labour in India is possible; in fact, the Mysore factory is entirely manned by locally trained labour.

The following table shows the production of Distribution transformers in India before and during the war. The figures of Government purchases in each year are also given.

Production of Distribution Transformers

Year	Production		Government Purchases
	Quantity	Value Rs.	Quantity.
Pre-war	60	60,000	Nil
1942	200	2,00,000	100
1943	600	6,00,000	150
1944 (Estimated) . . .	1,500	15,00,000	300

The respective share of each of the three producers in 1943 was as follows: 200 by the Bangalore factory, 250 by the Calcutta factory, and 150 by the Bombay factory. Before the war, Government was not buying any of the transformers made in India, most of its demands being met by imports. The industry is now controlled by the Government in an informal way through the control of raw materials, both imported and locally made, especially copper wire.

After the war, it can reasonably be expected that local production can meet the entire Indian demand of the smaller type of transformers. But it is highly doubtful if the Indian production will be able to compete successfully with imports in the open market. This is mainly due to the fact that Indian production is not on a sufficiently large scale basis as compared to the perfectly balanced standardisation and mass production obtaining in U.K. and U.S.A. In normal times the Electric Supply Companies control the sale of the transformers to a large extent, because they give extra facilities like free repairing, sale of transformers to the consumers of electricity on easy instalment pay ment system, etc. The Mysore Government owning the Electric Supply Company in Mysore was supplying the users of electricity with transformers which they used to buy from the market tender, before the Mysore factory began producing. The Governments of Madras and Travancore used to have stocks of the transformers which they sold to consumers of electricity on hire purchase system. Thus the consumers of electricity do not in most cases buy the transformers themselves. So the future of Indian transformer industry is dependant on what policy the electric supply companies, some of them privately owned, are going to adopt.

The inspection tests of the Supply less Department have found the average Indian transformers to be of good quality, in no way inferior to the imported ones. The Mysore Factory make was found to be inferior in some respects. probably due to the fact that before the war, the Mysore factory was enjoying a closed and large market in the Mysore State and hence had no incentive to improve the quality. The defects are being rectified to satisfy the specifications laid down by the Supply Department. Reports about the standard of performance of Indian transformers can be obtained from the Electrical Commissioner, the Engineer-in-charge and the Ordnance factories who are the principal users in war-time of Indian made transformers, used now in many theatres of war. The Government can place these performance reports along with the inspection reports of the Supply Department before the various Electric Supply Companies as part of the policy of encouraging this industry in the post-war period.

7. Black Adhesive Tapes

Black Adhesive Tapes in any standard width is used for electrical insulators. Before the war there was no production of this article in India, imports mostly from U.K. and Germany satisfying the entire Indian demand. The curtailment of imports on the outbreak of war encouraged the establishment of this industry. Now two firms in Calcutta are producing it: Rajgarhia Brothers and Commercial Bureau. Production began only in 1943, the total output of the year being only 2 tons, valued at Rs. 14,000 and the whole quantity was taken up by the Government. Production in 1944 is estimated

at 40 tons, worth Rs, 280,000 of which 30 tons are for Government's use, The machinery for its production is made in India and the raw materials, namely cloth, bitumen pitch and rubber latex are all available from Indian manufacture. The process of manufacture is simple. A definite quality of cotton cloth is dipped in a solution made of rubber and bitumen, dried electrically rolled and cut into tapes. Skilled labour is required only for cutting the tapes and was easily trained. The industry was started in India mainly at the instigation of the Supply Department, on account of its increased demand, and the Government is assisting the industry by getting the raw materials released from the various controllers to the extent of orders placed by the Supply Department

It is estimated that the present production, namely 40 tons year will be sufficient to meet India's peace-time demand in full. Nor is it likely that Indian industry will be unable to compete successfully with the imports in the open market, even though at present the industry suffers from lack of proper equipment. The machinery used is of an improvised kind and most of the work is done by hand. The position of this industry as a key industry in the sense that black adhesive tape is absolutely essential for the use of electricity calls for steps to prevent its death in the post-war period.

8. Electric Motors

Electric Motors are required for various power drives in every industry and also for domestic purposes, irrigation works, etc. The principal raw materials and components used are:—

(a) Silicon steel stampings,
(b) Cotton covered copper wire,
(c) Ball and Roller bearings,
(d) Insulating materials.

Electric motors were being manufactured in India before the war, but only on a small scale, by P. S. G. and Sons Industrial Institute, Coimbatore. The annual output of the firm came to about 200 motors, worth about Rs. 40,000. The balance of india's demand was met by imports. (In 1938-39 imports came to the value of Rs. 63,12,027).

With the outbreak of war, the industry expanded considerably. In addition to the expansion of the production of P. S. G. and Sons' Institute, 5 more firms entered the field of production. The new firms are listed below, with their production figures for 1943.

		Production in 1943	
(1)	Associated Electrical Industries Manufacturing Co. Calcutta . .	1,600	motors
(2)	Crompton Parkinson Ltd., Bombay	5,600	,,
(3)	Kirloskar Bros. Ltd. Kirloskarwadi	400	,,
(4)	British India Electric Construction Company, Calcutta . . .	800	,,
(5)	Metropole Works Amritsar	700	,,
	Total .	9,100	,,

Adding to this the production figures for 1943 of P. S, G. & Sons' Institute, which came to 900 motors, the total production for 1943 comes to 10,000 motors, worth Rs. 20 lakhs, double the quantity produced in 1942. Of the total Indian production, Government purchased 500 motors in 1942 and 1,200 in 1943. Production for 1944 is estimated to reach the figure of 20,000 motors, of which the Government's share will be about 2,000. The great increase in production was partly due to lack of imports (imports in 1940-41 came to only Rs. 32 lakhs). but more due to the increased demand coming from the Ordnance factories and workshops, and the various industries which expanded during war time, like textiles, leather ect. The machinery required for the expanded production was mostly obtained from U. K. and a few from U. S. A.; some of the plants, however, were made in India. Skilled labour necessary was trained locally.

Most of the raw materials are even now being imported. Silicon steel stampings were coming from abroad till 1944; since then the new stamping plant at Bombay is supplying this article. The original silicon stteel sheets

have however to be imported. Ball and roller bearing are entirely imported, and the insulating materials are also imported to a very great extent. Thus of the four important components used, only cotton covered copper wire is indigenously abtained.

Since the locally available raw materials for this industry are controlled by the Government, and license is required far importing the rest, Government is exercising some amount of control over production. The monthly production reports are submitted to the Government by the firms and after the Government orders are met, the balance is released to the civilian market at controlled prices.

In spite of recent expansion, our production of electric motors is still confined to three-phase squirrel cage small denomination electric motors, and even these are hardly comparable in quality to the imported article. As a more rapid industrialisation of India is bound up with the increasing generation of electricity for motive power, a vast demand for electric motors of all types is bound to arise, and hence the need for devoting increasing generation is bound to arise, and hence the need for devoting increased attention to the manufacture of electric motors.

9. Electric Wires and Cables

Before the war most of India's requirement of electric wires and cables were met by imports, the chief importer being the Indian branches of the large British Cable firms like Henleys, Calenders, Glover etc. In 1938-39 the value of imports came to about Rs. 132 lakhs. There was only one factory in India producing these articles, namely the Indian Cable Company at Tatanagar, but its output before the war was only a small fraction of the total consumption of India. The Company was producing only the ordinary trade types, the army demand for cables of special service specification being met entirely by importation by Great Britain. Air Craft cables were also not manufactured in India.

The trade types include Bare Copper Wire, Tinned Copper Fuse Wire, Cotton covered winding wires and various types of Rubber insulated cables including lead-covered and armoured cables.

In the war years two important developments have taken place in the industry. Firstly, Government has very recently put up a factory at Tatanagar near the Indian Cable Company's factory, for manufacturing 'D' Class Signalling Cables solely required by the Army. The Indian Cable Company's factory could not be made to produce 'D' Class Cables without curtailing its production of ordinary trade types which are also in great demand. The new factory, estimated a cost of half a million pounds is one of the most up to-date manufacturing units of its kind in the world. It is the outcome of one of the recommendations of the Roger Commission. Another war time development is the establishment of a purely Indian manufacturing concern, namely the National Insulated Cable Co. of India Ltd. The factory is only in its early stages of development, its production at present being confined to Bare Copper Wire which was in acute shortage in the first year of the war. Tne company was planning to establish its factory in Calcutta, but the Government's policy of decentralising industries led to its establishment at Mahgaon near Allahabad.

The total Indian production is much higher than the pre-war figure due to abnormal war time demands and restriction of imports. Indian Cable Company has had to work three shifts, and skilled labour to man the new production was trained locally—over 1,600 workers are employed in the factory of the Indian Cable Co., and 500 in the new Government factory. In 1943 production of Rubber insulated Cables was about 20,500,000 yards of assorted sizes of which 98 per cent went to Government use. The pre-war production of these cables was only 6,658,800 yards annually. About 190 tons of winding wires and 7,500 tons of bare copper wires were produced in India in 1943—20 per cent of the former and 82 per cent of the latter were taken by the Government. Imports, however, are still coming in considerable quantities, mostly from Great Britain

The chief raw materials required for the manufacture of cables and electric wires came from abroad before the war. Lead, rubber, (pale crepe and smoked sheet), Hessian, French Chalk, Barium Sulphate, Paraffin Wax and Naphtha were obtained from Burma. But now they are all available in India. Sulphuric acid; Cotton (glaced yarn, fine yarn and medium and coarse yarn) and galvanized iron are also obtained locally. Some of the raw materials are still being imported, chief of them being Black Copper Rods, coming from Canada and South and East Africa. Tin, which was previously obtained from Malaya now comes from Kenya and China.

The Indian Cable Company is under the statutory control of Government, by which the production of the firm is carried on under instructions from the D. G. M. P., and on the 7th of every month a statement is submitted to the D. G. M. P. showing the exact figures of production during the previous month. The Company is prohibited from selling or otherwise disposing of any insulated wire and cable except under a written authorisation from the D. G. M. P. or the officer authorised by him.

Through the supply of controlled raw materials, Government is exercising some control over the other firm also. The industry is getting special treatment in that the import of copper-rods is duty-free.

In the period after the war, acute competition from the British concerns is certain. It is however, to be expected that Indian Cable Industry, with its decreasing dependence on imported raw materials, will survive the struggle. Even if no export market is developed, the home market is sufficiently extensive, and cables are essential for new building construction and all electrification schemes which are surely to be developed on a large scale after the war. Further, the Indian Cable Industry is already well-established. Nor is the quality of Indian product in any way inferior to British make which sets the world standard. Indian wires are being extensively used for "deghaussing" fighting ships and ships of the merchant marine. In fact, one of the biggest men-o-war in the world is fitted with Indian wires and cables.

10. Conduit Pipes.

Conduit Pipes can be divided into two classes:—(1) Solid Drawn, (2) Welded. Both these types could be supplied either galvanised or black enamelled. They are an important though not indispensable item of the electrical goods. In size they vary from ½" to 2½" diameter. They are used for covering the electrical wires and are necessary for inside-the-wall wiring. Though wiring could also be done without conduit pipes, it is essential that wires near high temperatures should be carried in conduit pipes. They are also essential for flame-proof and gaseous installations.

India was depending entirely on imports before the war for Conduit pipes, and they came mostly from U.K. With the outbreak of war a few firms have entered the field to take advantage of the restrictions of import and abnormal war demands. They are, however, producing only Welded Black Enamelled Conduit Pipes. The firms are the following :—

1. Muralidhar Pannalal, Calcutta.
2. B. Agarwala & Co., Calcutta.
3. Sexaria Pipe Works, Calcutta.
4. National Cycle Manufacturing Co., Delhi.
5. Indian Conduit Industries, Panipur.
6. M. J. Bagla, Calcutta.
7. B. D. Brothers, Calcutta.
8. Indian Hume Pipe Co., Bombay.

The process of manufacture is simple. Black steel sheets are first cut into exact strips; then they are bent and welded. The machinery required for this purpose is steel roller to even the sheets and roll them in pipes, and welding plant for welding the pipes. Except the Indian Hume Pipe Company all the firms are using gas welding plants manufactured in India. Steel rollers used by these firms are also locally made. The Hume Pipe Co. uses an imported electric welding plant. In fact, its process is not welding proper, but joining the pipes when they are in a melting condition. This is a work of precision more difficult (since unevenly joined pipes are useless) and hence more costly. The raw-

materials required, namely Mild Steel Sheets and Carbide are availabe from Indian manufacture. The labour required is not highly skilled and could be trained easily.

The Government exercises no control over the industry. For the Government requirements from time to time, tenders are invited, and the firm quoting the lowest price is supplied with the two necessary raw materials, both of which are controlled by the Government. The rest of the production over which the Government exercises no control is taken up by the civilian market.

In small quantities enamelled welded conduit is still being imported into the country and is entirely under the control of the Electrical Directorate of the Supply Department. The Engineer-in-chief also imported conduit pipes from U. S. A. But the specifications of the American conduit differs considerably from that of the British Standard Specifications with the result that the accessories required for the American conduits are not readily available here. On account of these difficulties as well as the restriction on the use of conduits only for special type of insulations in India, no further quantities of conduit were required to be imported from U. S. A.

The new production will not be able to compete with imports after the war because the Indian make is definitely of inferior quality not conforming strictly to the British Standard Specifications. This is solely due to the crude methods of production now being adopted by Indian factories. Because of the difficulty of getting suitable machinery from abroad, production is being carried on by incomplete plants improvised in India. The price of the Indian product is also high, when compared to the price of imports. The pre-war price of conduit pipes (imports) was Rs. 12 per 100 ft. Now Indian Conduit Pipes are valued at Rs. 26 per 100 ft., whereas imports even now cost only Rs. 15. This disparity in cost is largely due to the small scale production carried on in India in contrast with the mass production in countries like U. K. and U. S. A.

ELECTRICAL INDUSTRIES : PROSPECT

Although the Indian production of electrical goods has expanded considerably in war time, the present output is insufficient to meet our demands in full Hence the need for imports in the case of most of the articles.

As stated in the introductory remarks, the Indian industry is still dependent largely on imported raw materials and component parts. This is one of the causes for the slow progress of the industry in war-time, and the position is not likely to change much in the post-war period unless technical progress in India forges ahead in the meantime.

It cannot be said that in the matter of labour, the Indian electrical engineering industry is dependent on foreign skill in any absolute sense. Though the manufacture of most of the articles calls for skill of a specialised kind, Indian manufacturers have been able to train the labourers locally without much difficulty. Some of the larger Indian electric firms, like the India electric Works deserve special mention for the work of training labourers in India in the intricate processes connected with electrical manufacture. Labourers trained by such pioneer firms have helped in establishing other firms subsequently.

In the matter of quality, the indian products generally have not reached the standard of imports except in a few cases like fans and lapms. If with the help of experience gained in war time, efforts are not made to improve the quality of the Indian products, Indian manufacturers may have to face the severe competition of cheap imports of better quality goods from abroad. Scientific research can do a great deal for improving the quality of our electrical goods, and it is high time research centres are organised for this purpose. With the advance of research, it may be possible to start the production of the various other electrical articles, instruments and equipment, including air-conditioning plants and refrigerators. Already some firms are doing excellent work in the manufacture of electrical and electro-therapic instruments of good quality and are meeting the war requirements for such articles. If these developments are maintained, Indian electrical goods will not only meet internal demands but may also find growing markets in the Near East and Africa in the post-war years,

SECTION VIII.—SHIPBUILDING AND MARINE ENGINEERING

General—Shipping comprises three main operations, namely (1) Construction of the hull; (2) making and fitting of the boilers and machinery; (3) Electrical installations etc. Shipbuilders maintain their own snipyard, where the hull is made and the wnole ship fitted out. Tne construction of the hull is allied to structural engineering, but has to be undertaken in workshops (shipyards) with a special set up. The boilers and machinery are either made by the shipbuilders in a separate workshop or are made for them by firms specialising in such work. The third item is generally undertaken by electrical engineering firms,

Thus, engineering to one form or another enters into the various processes connected with shipbuilding Marine Engineering is the term applied for the specialised mechanical processes, namely the making and maintenance of the machinery and auxiliaries required for ships.

Shipbuilding and ship repairs are the two essential parts of the industry under consideration. Marine Engineering enters into both: the construction and fitting of new machines and auxiliaries enter into the former; the maintenance and repair of machines into the latter. Shipbuilding and ship repair are intimately inter-connected, and are generally done by the same firms. Today, in war-time, ship repair is much the bigger concern, for obvious reasons and this is especially so in India which is now the base of Allied operations against Japan. Normally, However, shipbuilding is the more important concern, especially from the industrial point of view, and hence the precedence given to it in this note.

1 Ship Building

A. Before the War

Ships have been built in India from time immemorial, but the position changed materially when wooden sailing vessels were replaced by steel-made steam-driven ships as a result of the epoch-making improvements in marine construction technique which took place in the mid-19th century. In the East India Company's days, fine sailing ships were built in India especially on the west coast, with the teak of the Western Ghats which was then the best material available for the construction of ships. Some of the vessels thus built in India did splendidly in the British fleet as well as in the mercantile marine. After the introduction of steam navigation the nature of shipbuilding changed and India became greatly handicapped in this matter. Before the war all sea-going vessels used on the coasts of India were built in Great Britain.

Although large vessels were not built in India, inland water steamers from 20 ft. to 300 ft. long, harbour launches, motor launches and dumb craft for transporting cargo to and from ships were being built in large numbers. In Bengal the construction of such inland the water vessels was undertaken by "The River Steam Navigation Co.' and 'India General Navigation and Railway Company'. Such vessels have been in great demand there because there is an extensive inland trade passing through the broad rivers and lagoons of that province. Iron and steel, textiles etc. were taken into the interior, while tea, jute, and other inland produce was carried to the harbour for exportation or local consumption.

Country craft have always been built in large numbers, especially on the west coast, and numerous skilled craftsmen found employment in this industry.

In the years immediately before the war, some advance had been made in the construction of the larger vessels also. Sea-going tugs, up to 440 tons, were built at Calcutta. The enterprising Indian firm, the Scindia Steam Navigation Company, laid out a large shipyarn at Vizagapatam for the construction of steamers up to 8,000 tons (deadweight). Most of the machinery required—Punching. Beam-bending and Angle shearing machinery. Plate straightening and Bending Polls, Pneumatic and other Machine Tools, cranes etc.—had been obtained from the U. K. but further progress was delayed by the war taking a serious turn.

B. War-time Developments

Various circumstances made it necessary for the Government to take action in regard to shipbuilding and marine engineering. , As the shipbuilding firms in U. K. Australia, Canada and South Africa were overloaded with orders for ships both naval and merchant, it was found impossible to bring out from the U. K. vessels required for the defence of India. An urgent need also arose for mine-sweepers and escort craft.

The Government of India commenced action even before the war situation became serious. Under the laid of the then Commence Member (the Hon'ble Sir Ramaswamy Mudaliar') a survey of the facilities available in India for shipbuilding was made. This survey disclosed that as far as the established firms were concerned the coastal craft could be built up to 260 ft. in length launching craft about 14 ft. It was also found that boilers, machinery, steam and internal combustion engines, including all auxiliary machinery and electrical equipment had to be imported.

A preliminary meeting was held in Simla in May 1940 at which the limitations of the shipbuilding firms were ascertained and their capacity for building certain types of craft roughly indicated. This information was passed on to the Admiralty, who then gave a programme of construction which, India was required to undertake. The programme consisted of seventeen M/S-A/S trawlers, eight 110 ft. motor launches, twelve 72 ft. harbour defence M. I.'s and four 105 ft. it motor mine-sweepers. In view of the limitations of the firms engaged in the work the Admiralty undertook to supply all propellant machinery, electrical machinery, first fitting stores, permanent stores and naval stores, some from the U. K. and some from Australia and U. S. A.

On receipt of the snggested programme from Admiralty which was based on India's needs a Director of Shipbuilding was appointed under the D. G. M. P. and another meeting was held in Simla in July 1940 at which representatives of the various major firms were present, with the Supply Secretary, Mr. (now Sir) E. Jenkins, in the chair. As a result of this meeting, contracts were placed by the Director of Shipbuilding through the C. C. P. (M) for the construction and fitting out of various types of craft.

The building programme was distributed among the various shipping firms at Calcutta. Bombay Karachi and Cochin.

Various difficulties arose in the carrying out of the programme, chiefly in regard to the supply of steel materials. At the outest, Admiralty had promised to supply steel. Later this was found difficult and steel had to be obtained in India. This naturally caused delay in many ways,—(1) deliveries were not made in the period for which they were arranged; (2) the order of delivery given to the producer was not kept; for example, keet plates are always required first, but in many cases deck plates were delivered first and keel plates not until some time more than half the other materlals had arrived and no work could be begun until the keel plates were available, (3) delays in the receipts of machinery and equipment from overseas owing to bottlenecks in production, shortage of shipping space and losses by enemy action.

In 1942 a large programme of barge building and small craft varying from 10 ft. dinghies to 42 ft. harbour launches was pushed through. This caused some trouble in respect of delivery of timber which was quickly overcome Difficulty arose in regard to fastenings also, and this difficulty too has been over come. Cheese headed bolts, spike nails etc. are now produced locally. fairly good copper nails and roves are now being produced, but the brass screws locally produced are far from satisfactory. Even timber has been in short supply lately, and consequently, the 1944 programme for 800 wooden craft may not be fully carried out.

Other difficulties experienced are:—(1) firms had never done work to the standard demanded by Admiralty specification; (2) competent supervisery staff is lacking in the firms; (3) nor is the Directorate General (Shipbuilding) having

a suitable inspecting staff; (4) showness of delivery of locally ordered components and the poor standard of workmanship and in many cases large discrepancies from the dimensions given on drawings have caused great inconveniences.

In spite of such obstacles, the shipbuilding industry has made considerable progress and the new constructions cover a wide range from steel mine-sweepers down to local defence craft. Fairly large orders for life boats and other smaller craft down to 16-foot dinghies have been carried out. Till June 1944, new constructions numbering about 700 have been carried out, and these range from 15 basset trawlers, 2 escort vessels 254 small craft (from 10 ft. to 32 ft.) about 1,100 vessels of all classes are under construction now, not to speak of the large numbers of wooden barges for carrying cargo. The Royal Indian Navy is thus steadily growing.

Machinery.—Marine Engineering in India was in a very undeveloped state before the war. Boilers and large machinery were all imported, and only the smaller engines and appurtenances were made here. Marine engineering therefore consisted chiefly of runniug repairs, and overhauls of machinery and boilers of ships.

After the construction of vessels on a large scale than before began in India, it was realised that all the machinery required cannot be imported, and it became necessary to take up the manufacture of some of the machinery. Towards this purpose, attempts were made to utilise the capacity available in India in the steel production centres and railway works.

An important order was placed in India in 1942 for machinery, main and auxiliary, for M/S-A/S trawlers, 26 sets. This order was distributed as follows:

Bedplates—Tata Iron and Steel Works, Jamshedpur.
Cylinders—Railway Works, Kanchrapara.
Crankshafts, Condensers, etc.—Burn & Co.
Pistons and Piston Rods, Crossets.—Railway Workshop, Lahore.
Fan Engines.—Railway Workshop, Amritsar.
Windlasses and mine-sweeping winches—
Hyderabad Railway Works.
Port Engineering, Calcutta.
Boiler mountings—
Binny & Co., Madras.
Port Cimmissioners, Calcutta.

There have been serious delays in the deliveries of the various items. One of the causes is the lack of adequate machining capacity for bedplates, cylinders etc. and forgoing capacity for crankshafts components. Further the instructions given on the drawings were in many cases not adhered to.

2. Ship Repairs.

Before the war ship repair work was confined to the two major ports of Bombay and Calcutta and the firms did little beyond repairing and maintaining a small number of ships plying in the Indian waters. Small inter-voyage repairs were also carried out in the case of ocean-going vessels which called at Indian ports At Bombay and Calcutta graving docks existed and these were used mainly for cleaning and coating the under-water hulls of merchant ships and maintaining the under-water fittings.

In 1941 India was called upon to undertake major repairs for ships operating in the North African area. Such demand became more intense in 1942 when Japan entered the war. When the Far East ports fell, India became the front line for operational purposes. Men, equipment and stores had to be despatched to India *via* the Cape route. Even the men and stores for the middle East had to come *via* the cape. In these circumstances, the need for repairs increased tremendously and numerous ships having been damaged by enemy action (by bomb, mine or torpedo) resorted to the nearest Indian port for repair.

Thus an immense burden was placed on the slender ship repair sources in Indian ports. But India was not equipped for undertaking such work. The

plant and equipment available in Indian ports were not up-to-date, nor in good condition.

In view of these developments, a Director of merchant Ship Repairs was appointed in India in 1942. With the growing importance of ship repairs as well as shipbuilding, a Directorate General of Shipbuilding and Repairs was also set up with Bombay as its headquarters.

The chief materials required for ship repairs are commodities made from steel and non-ferrous metals, boiler and condenser tubes, timber and electrical fittings including cable. At one time arrangements had been made to import steel from the U. K. and U. S. A., but now except for specially long and wide plates not rolled in India, all ship-repair steel is supplied from Indian production. Most of the non-ferrous alloys required are also made in India now, Part of the electrical cables needed are also abtainable in India. The timber required is teak and coniferrous wood, both obtainable in India, but as supplies are now running short alternative jungle woods have to be used, as well as supplies imported.

In spite of these various difficulties a great deal of repair work has been carried out and much of it is of the type not undertaken in India previously. The extent of the repairing work done can be seen from the following figures for the calendar year 1943 :—

Merchant Ships repaired during 1943

Port	Number	Gross tonnage
Bombay	965	6,311,133
Karachi	305	1,671,943
Cochin	50	250,754
Calcutta	653	3,433,835
Vizagapatam	54	134,401
Madras	92	504,753
Total	2,219	12,432,962

In addition to these, 243 naval ships were also repaired during the same period. These include 81, Royal, 23 Australian and 13 Allied Naval ships.

With the increase of enemy operations in the Indian waters, it became necessary that the merchant ships plying in these waters should be defensively armed against enemy attack by surface ships, submarines or from the air. Ships were armed by fitting guns. Protection for the gun crews, the bridge, etc., is also provided and for this purpose plastic armour is used. The manufacture of this armour was started in India and between April 1942 and July 1943, 211, 202 sq. ft. of this material weighing 3820 tons was fitted in 324 ships.

A salvage organisation has also been created for rescuing men and ships in peril, along India's extensive coast line.

3 GENERAL.

Firms—.—The following is a list of the firms engaged in shipbuilding and repairs, and against each is shown the nature of the work undertaken,

Calcutta.

M/s. Garden Reach Works	Ship repairs, New construction steel and wood—11 types, Repairs to inland water craft, large and Small.
,, Hooghly Docking and Engineering.	Ship repairs New construction steel and wood—7 types. Repairs to Small inland water craft.
,, Shalimar Works Ltd.	Ship repairs. New construction steel and wood—4 types. Repairs to small inland water craft.
,, India Navigation and Railway Co.	New construction steel and wood—4 types. Repairs to inland water craft, large and small.
,, Port Engineering Works.	Ship repairs etc.

Bombay

Mazagon Docks	Ship Repairs. New construction wood 4 types.
M/s. Alcocks Ashdown and Co.	Ship Repairs. New construction steel—3 types.
,, Scindia Shipyard	Ship repairs. New construction steel and wood—6 types.
,, Ahmadi Shipyard	New construction wood only—9 types.
,, Art Floorings Ltd	Originally cabinet makers, this firm took up shipbuilding in war-time. New construction wood only—8 types.

Karachi.		
M/s Herman and Mohatta . .	Ship repairs.	New construction steel and wood—4 types.
„ Alcock Ashdown (new establishment)	Ship repairs.	New construction steel and wood— 4 types.
Cochin.		
„ Brunton and Co. . . .	New construction 1 type only wooden aircraft.	
Vizagapatam.		
„ Scindia Shipyard . . .	Cargo barges wood cartamarans etc. ship repair.	

A word of explanation is necessary regarding the Scindia Shipyards. A shipyard was constructed by the firm at Vizagapatam, and early in 1942 several mine-sweepers and basset trawlers were built there. Owing to enemy action in April 1942, their activities in Vizagapatam were suspended and under instructions from Government they had removed their machinery to Bombay where a new shipyard was fitted up for shipbuilding and repair. Towards the end of 1942, however, work was restarted at Vizagapatam, and shipyard was laid out with the necessary facilities for ship repair and construction work, with machinery taken from Bombay.

Labour.—The question of skilled labour was a serious problem from the very beginning. There are indeed in the country craftsmen with experience in constructing the traditional types of the wooden country craft but it was not an easy job to train them to undertake new work connected with mine-sweepers etc. The technical Training Scheme may later prove useful but it takes time to materialise. Some Chinese labour became available after the fall of Burma, and they were employed. Lately Italian prisoners of war have also been employed. The total number of men employed in shipbuilding and ship repair industry is about 50,000. Supervision of labour has been found a difficult problem. This was partly relieved by employing evacuees from Singapore and the Far East. Some supervising staff was brought out from U. K. The labour problem is still a serious one and it calls for careful tackling.

Post-War Prospects

There is no doubt that India is now equipped for building smaller vessels and this industry is bound to expand after the war. The building of the larger vessels is a difficult problem. The Scindia Steam Navigation Co. has equipped their shipyard at Vizagapatam to build steamers up to 8,000 tons. They have also obtained the services of expert Naval engineers from the U.K. There are various difficulties to be overcome if the scheme is to materialise. Some of them have been overcome lately, and the experience recently gathered will be helpful in post-war years. If recent advances in Indian metallurgical industry are maintained, it may be possible to manufacture in India several of the components required for building large ships—structurals, plates and castings. But this involves the establishment of several ancillary industries, Technical skill must also make large strides. All this will take time. The pace of progress can, however, be quickened, if work on a carefully devised plan is undertaken.

SECTION IX.—AIRCRAFT

Aeronautical Engineering is a comparatively recent development even in Western countries, and war has been a very dominant factor in this development. Before the war, India was ill-equipped even for the repair of aircraft, and its manufacture was therefore a far cry. After Japan came into the war, air force operations assumed great importance in India, and the growing strength of the Indian Air Force as well as of the Allied air forces operating in India necessitated urgent arrangements for the repair and maintenance of aircraft and the manufacture of spare parts and equipments and even of whole planes. As we will see, these urgent requirements were met by the combined efforts of Government and private industrialists.

Repair and Maintenance

The first attempt in this line was made by the Hindustan Aircrafts Ltd., which established an aircraft factory at Bangalore in 1940. It began as an assembly plant, manufacturing planes from imported parts. This was a private

concern, but the Government of India and the Mysore Durbar owned a substantial portion of the shares and were represented on the board of management. In 1941, the factory turned out its first aeroplane. Subsequently the manufacturing programme of the factory was given up in order to give absolute priority to servicing, repair and overhaul of all American purchased aircraft, aero-engines and aircraft equipment used in India. The work is done by Indian craftsmen who have been trained either at the factory or in the Civil Aviation Technical Training Schools in India. The factory is now the major repair depot of the Tenth U. S. Army Airforce. It also serves a portion of the American aircraft held by the R.A.F. A change has now come about in the ownership of the company. The financial risks and administrative complications involved in the working of the company as a commercial concern were great and therefore the shares held by the public were bought up by the Government of India. The Mysore Government retains its shares in the concern, but has no share in the management.

For the repair and maintenance of British and Indian aircraft, operating in India, Civil Maintenance Units (C.M.U.) were opened in different stations, under the D.G.M.P. (Aeronautical Division). By the end of 1943, eight such units were in operation. Two of these units are engaged in repairing barrage balloons and signal equipment. These units employ Indian staffs which are supervised by R.A.F. technical personnel specialised in this work. Excepting for the unit at Cawnpore which is controlled by the Government of the U.P. all other units are in the hands of civilian agencies. Even though there has been an acute shortage of spare special tools and jigs, the Civilian Repair Organisation had repaired about 700 aircraft and 1,750 aero-engines by the end of May, 1944, and in addition had done a large amount of aircraft modification and inspection work. When the expansion schemes on hand are completed by the end of this year, the planned monthly output of 103 aircraft and 279 engines would be possible. Repair of propellers, turrets, wireless sets instruments, M. T. vehicles and many other items of Air Force equipment has also increased in 1944. The output of repaired instruments from one Unit alone was more than 2,000 in May, 1944.

Contracts have also been made with the Tata Aircrafts and Indian National Airways, for repair and maintenance of planes. As a result, early in 1944, three Tata Civil Maintenance Units have commenced work. Many other civilian firms all over India have also been engaged in the repair work, and their output is increasing rapidly.

Salvage of serviceable or repairable parts from obsolete aircraft, has been an important feature of the repair work. The recovered parts are used for the repair work and for the manufacture of new parts and equipment. For this purpose a new Civil Maintenance Unit controlled by the Tata Aircrafts has been formed at Lucknow, to start work in July 1944.

Manufacture of aircraft equipment and parts.—Efforts were also made to manufacture aircraft equipment and parts in India, but these have been handicapped by the delay in getting machine tools from abroad and the shortage of technical staff. The lack of facilities for training in aeronautical engineering in India has been a serious handicap. Moreover the productive capacity of the country is already fully engaged for other Defence purposes. Nevertheless, during 1943. 13,270 different items covering many thousands of large and small parts were manufactured in the various factories in India for the use of the R.A.F. A large number of small spare parts both for the airframes and aero-engines were also manufactured for the use of the Civil Repair Organisation. This work is done by the Civil Maintenance Units and the civilian firms controlled through the six regional centres, namely, Madras, Bombay, Lahore, Calcutta, Cawnpore and Karachi. Spare parts, A. G. S. items, ground equipment, engine test benches, workshop tools and plant and equipment of all descriptions are being manufactured to the high standard set by the A.I.D. The range of items has been limited by the type of materials available in India;

it could have been extended considerably if special steels and materials which cannot be produced in India had been made available. Considerable assistance has been given by the Ordnance Factories, and three of them have now been handed over entirely to D.G.A. for aircraft work. These factories are well-equipped with modern machine tools and plant, and should be in full production by the end of 1944. They are already manufacturing Base Tool Kits and Flight Tool Kits, which cover 652 items, involving the production of about 12,000 tools. Tool Kits are also made by other armament factories in India on a smaller scale.

There has been considerable progress in the manufacture of aircraft jettison tanks lately. In 1944 (till August), 10,000 aluminium and 5,000 plywood Hurricane tanks and 3,000 Spitfire tanks have been completed. Plans are in hand for the production of 10,000 Thunderbolt tanks of larger capacity by the end of 1944. Experimental tanks of a new form of construction developed by Indian scientists have been successfully made. These employ indigenous materials (jute impregnated with shellac on a wooden frame) which are cheap and in plentiful supply. A large programme of fitting special vehicles with W/T and Radar equipment in locally designed and constructed bodies is due for completion by the end of 1944. but this will depend on the obtaining of special equipment from U.K. Lack of special aircraft steel and light alloys has affected the manufacture work, but a small quantity of such articles has now been obtained, and local industries are being encouraged to produce many of the above items, according to the specifications laid down. The possibility of expanding the number of items which can be produced in India is under investigation and a suggestion has been made that a number of technical officers of the U.K. Ministry of Aircraft Production with knowledge of production methods and ability to assess capacity should visit India.

Parachute manufacture is also undertaken in India; a new factory at Cawnpore is wholly devoted to this production. According to the production programme of the Supply Department. nearly 600 men.carrying statichutes, over 1,500 silk container parachutes for dropping equipment and nearly 2,300 cotton parachutes for dropping supplies have now been completed.

The erection of new aircraft is now undertaken by the Tata Aircrafts who are maintaining a separate Civil Maintenance Unit entirely for this purpose. Its output in 1944 has averaged 70 aircraft per mensem.

Directorate General (Aircraft)

In December, 1942, a new division known as the Aeronautical Division was added to the D. G. M. P. to look after the repair and maintenance of aircraft and the manufacture of Air Force equipment and aircraft parts for the Air Forces operating in India. But it was soon found that a separate Directorate General was necessary for this purpose. The Directorate General Aircraft was therefore constituted in October, 1943, with Headquarters at Calcutta. It consists of two main Divisions, one dealing with 'Manufacture' and the other with 'Repair and Maintenance'. The D.G.A. handles for the Air Forces all the repair and maintenance work of aircraft, motor vehicles and motor boats including engines, instruments and accessories, barrage balloons signal and wireless equipped, etc. In addition to the Headquarters organisation, there are circle offices at calcutta, Madras, Bombay, Cawnpore, Lahore and Karachi. These circles are in charge of a deputy Director who is responsible for surveying and utilising the capacity within his circle. The inspection work undertaken by the D.G.A. is carried out by the staff of the Aeronautical Inspection Service under the direction of the Air Headquarters.

Post-war Prospects

Thus the aircraft industry in India is entirely a war-time development. Such sudden growths necessarily lack stability. The future of the aircraft industry in India is dependent on the development of a market internally. But the Indian market today is not large enough to support an aircraft industry. Air transport however is bound to become more popular after the war in this vast sub-continent of long distances. But, anticipating such developments some say, it may not be very wise to embark forthwith on the manufacture

of aircraft in India. There is every necessity to build up the industry, but it has to be done by stages. The Indian aircraft industry will for long have to depend mostly on the internal market, as the overseas markets are likely to be supplied by the fully developed aircraft industry of the U. K. and U. S. A. Even in the internal market, the quality of the aircraft will be the deciding factor, as the aviation services will have to pay special attention to efficiency and security of service.

SECTION X.—WELDING AND PRESS WORK

General.—By press work is meant the process of giving a desired shape to an object, *e.g.*, manufacturing the bodies of motor cars, tin boxes, etc. Welding is the process of fusing two metallic bodies into one homogenous block.

Press work in India was well-established before the war, since light and medium pressings are required in the making of most utensils, but heavy pressings as, for example, those required to make motor-car bodies, had not been taken up since the machines for the work did not exist in India. Nor was there any demand for it, as the whole of the Indian demand was met by imports.

In war time heavy pressings, generally called 'hot pressings', have been taken up; but this comes under structural engineering. In light and medium pressings much process has been made in war time. Formerly the capacity was limited; for instance. 4-gallon drums were made only by two firms, and that too on a limited scale.

The urgent war demands have led to the growth of pressing work as a cottage industry, since any small fabricator with a little welding capacity could undertake the work. This is now going on all over India, especially in the Punjab with its many skilled iron workers. Under presswork and welding, the following articles are important and the war time developments in their production are noted below :

1. Petrol Cans and Oil Containers

These include petrol cans (2 gallons), kerosene oil tins (4 gallons and 1 gallon), drums used for lubricating oil, mineral oil, vegetable oil and paint (4 and 5 gallons), bigger containers like 10 gallon drums, 20 gallon drums, 42 gallon casks, and small cans for food products.

The imports into India, of petrol and kerosene in containers are negligible when compared with India's consumption. (Most of the lubricating oil used in India, however, was being imported in containers). Hence there was a large demand for petrol and oil containers and these were being made locally by the oil companies, before the war, Burma Shell Co. had an average monthly output of 121,430 one gallon-tins manufactured at its installations at Calcutta, Bombay, Marmagoa, Madras, Ernakulam, Coconada and Karachi. These installations and the one at Chittagong together had an average monthly output of 1,373,200 four-gallon tins. Two-gallon tins were being made by this Company only at Bombay and the average monthly output came to about 32,000 This company had installations in Rangoon also. The Assam Oil Company's installation at Digboi was producing on a monthly average 390,000 four-gallon tins. The Attock Oil Company's installation at Rawalpindi was making 2,040 one-gallon tins. 4,830 two-gallon cans and 6,100 four gallon tins a month. The Standard Vacuum Oil Co.'s installations at Calcutta, Bombay, Marmagoa, Ernakulam, Coconada and Karachi were producing on a monthly average of 619,770 four-gallon tins. Its installation at Bombay was making 9,800 one-gallon tins a month. Thus, the total monthly Indian production of these articles came to about 257,270 one-gallon tins, 72,430 two-gallon tins, and 2,648,070 four-gallon tins. This does not include the output of the Punjab Sheet Metal Works at Jallo, near Lahore, with a plant for the production of two-gallon cans and four-gallon tins, since their product was of inferior quality. Recently, however with the extended use of curb-side pumps, the use of two-gallon petrol cans was becoming less common and the oil companies principally Burma Oil Co., curtailed its production considerably.

Facilities for the manufacture of drums and barrels were more limited in India, and when the war started only one firm, Indian Galvanising (1926) Ltd.,

Howrah, was making barrels, and only this company and Barry & Co., Naihati were making four-gallon drums. These two were paint manufacturers and were making the containers principally for their own use. Previously the Shalimar Paint, Colour and Varnish Co., Calcutta and Hadfields (India) Ltd., were also making drums of the five-gallon type. These drums are not normally used in the mineral oil trade. They are more in use in the vegetable oil and paint trades. Larger containers, like ten-gallon drums, twenty gallon drums, and fortytwo gallon casks (19 B.G. and 16 B. G.)were being made by the Burma Oil Co.

Raw materials.—Kerosene tins of one-gallon and four-gallon sizes were made from 30 Birmingham gauge tin plate obtained from the Tin Plate Co. of India. Petrol cans (two-gallons) are usually made of tin plate 27 Birmingham gauge. The Burma Shell factories which were manufacturing only for the civil trade were using 27 B.G. tin plate made by the Tin Plate Co. of India. The army petrol can is more durable than the ordinary one, and the specification is more exacting. The only army supplier in India before the war was the Attock Oil Co. and it was making the cans from 26 B.G. plate also obtained from the Tin Plate Co. of India. All drums and casks and barrels are made from galvanised or other suitable sheets obtained locally. Faucet bodies and caps for petrol cans were all imported from U. K. where only one firm had the special machines for their production. The faucet bodies and caps are more durable than the can itself and hence are used over and over again.

When war began, there arose a great demand for all kinds of containers, and oil companies which had curtailed or given up the production of cans and tins revived the industry, reconditioned their old plants and thus came to supply a large number of cans for Defence Services.

The following firms are now making containers to meet Indian demands mostly from the Governmet.

44. G. Barrels

(1) Standard Vacuum Oil Co., Bombay, Karachi, Calcutta and Madras.
(2) Texas China Ltd., Bombay and Karachi.
(3) Indian Galvanising Co., Calcutta.

41. G. Drums

(1) Standard Vacuum Oil Co., Madras.
(2) Indian Galvanising Co., Calcutta.
(3) Barry and Co., Calcutta.
(4) Marwar Galvanising Co., Calcutta.
(5) Poddar Engineering Co., Calcutta.
(6) Guha Brothers, Calcutta.
(7) Indian Metal Mfg. Co., Calcutta.
(8) Goodman & Co., Calcutta.
(9) Gajanand Rampratap Co., Calcutta.
(10) Metal Products Ltd., Calcutta.
(11) Kangal & Co., Calcutta.
(12) Dhur Galvanising Co., Calcutta.
(13) Continental Engineering Co., Calcutta.
(14) Shalimar Paint Works, Calcutta.
(15) Watkins and Mayor & Co., Jullundur.
(16) Guest Roberts & Co., Lahore.
(17) Upper India Metal Works, Amritsar.
(18) Chandiel Ram & Co., Lahore.
(19) Hassambhoy Jhetha, Bombay.
(20) Simpson & Co., Ghazibad, Madras and Bombay.
(21) Modern Engineering Co., Cawnpore.

2 G. Cans

(1) Burma Oil Co., Madras, Bombay and Karachi.
(2) Standard Vacuum Oil Co., Bombay, Madras and Calcutta.
(3) Attock Oil Co., Rawalpindi.
(4) A. K. Sarkar Ltd., Calcutta.
(5) General Supply Corprn., Lahore.

In addition to these containers, we have recently adopted a design for a two-gallon can known as 'Mid East' type, and 2 factories, i.e., The Metal Box Co., Calcutta and A. K. Sarkar Ltd., Calcutta are already producing it. The 'Mid East' can will probably take the place of two-gallon trade pattern, since it is a better type of packing.

Post War.—After the war, containers may not be an essential requirement of the oil trade. Ordinarily petrol and other oils are kept in storage tanks, and for consumption in towns, curb-side pumps are used. But in war time these were found inadequate, and the swift movement of the military called for the use of suitable containers of all sorts. This abnormal demand cannot be expected to last long and therefore the industry may not be maintained after the war in any considerable proportion. Kerosene oil tins, especially one-gallon size which was becoming very popular in the civilian market before the war, and drums for paints and vegetable oils may, however, continue to be in good demand, though not of the present size.

2. Other containers including Food-cans

Pre-war.—Production of open top cans for canned foods and general Line Cans for all other products packed in tins, was being carried on before the war by the Metal Box Co. of India. This Company is associated with the Metal Box Co, Ltd. in England, which operates 27 factories there, and also with factories in South Africa, Australia and Canada. It has also a mutual technical aid arrangement with the Continental Can Co. of America, the largest can-makers in the U. S. A. These world wide connections have enabled the company to perfect its methods of production by the pooling of technical knowledge and benefiting by the experience of others. The Company has three factories: two general Line factories, one in Calcutta and another in Bombay and an open top can factory at Okara near Lahore.

In war-time

In war time about 80 per cent. of the company's manufacturing capacity is devoted to war production. The scope of production has expanded to cover cannisters, stampings, military equipment, aircraft parts and munitions components, pressed out and fabricated from light metals. More than 80, articles of ammunitions and war-like stores are made by the Company's factories. In addition many millions of tin plate and blackplate containers have been produced for the packing of evaporated milk, pasteurised butter, cheese, margarine, golden syrup, coffee, condiments, tobacco, camouflage paint, lubricating oils, blanco, anti-mosquito ointment and many other army stores. The Company's production of webbing equipment runs into many millions of units by now. The Company's technical knowledge is also being made use of by about a dozen small indigenous tin-box makers and press metal factories who are now producing metal components for webbing equipment. The Company is also producing 'composite'. containers, thanks to the research work of its associated companies abroad. These containers consist of a spirally wound cardboard body, glued and waxed with metal ends ; by their use a saving of 80 per cent. of metal per container is achieved. The Company's plant is capable of producing approximately fourteen millions of these composite containers per annum. The Company also has an extrusion plant for the large scale manufacture of printed collapsible tubes. Depending on the size of the tube made, the capacity of the plant is between 12 and 18 million per annum. As much as fifty per cent. of the machinery used is of Indian make.

In peace-time, the main raw material used was the tin plate, and its consumption amounted to between 2,500 and 3,000 tons annually. In 1943, purchases of tin plate and its substitutes (*i.e.*, PCRCA blackplate and terneplate) exceeded 6,000 tons. In addition to this, a considerable tonnage of mild steel, M. S. wire, pure tin, lead, brass and aluminium was also consumed, principally in the manufacture of war stores. The labour force of the company has been increased from the pre-war figure of 1,200 to 3,000 to-day. Supervisers and foremen are being trained by the Company. A good number of executive posts is filled by Indians, but the superior engineering staff is entirely European, including a few Czech technicians recently added.

3. Lanterns and Lamps

Lanterns:—Before the war, hurricane lanterns, imported from America, namely Dietz Junior and Feuerhand 252, were greatly in use in India, and these conformed to the Army Service Standard too. In early 1930's, India-made lanterns, namely, Prabhakar and Dipti (manufactured by Ogale Glass Works, Ogalwadi, Oundh State, near Poona, and Oriental Metal Industries. Ltd., Calcutta) came into the market. After the usual tests, these lanterns were found suitable for military requirements also. Before the outbreak of war Government used to buy any one of the four brands mentioned above according to the rate quoted. But the bulk of the civilian demand was perhaps met by imported lanterns which were cheap and convenient.

When the war broke out, the demands from the Defence Services increased greatly and as imports were falling, the indigenous capacity was found far short of our requirements. Accordingly attempts were made to widen the sources of supply as much as possible. In the course of such attempts, Behar Lantern Factory, Dumraon, came into being but its output is still small. Owing to the uncertainty of imports from America, the question of relaxing the specifications laid down for the supply of lanterns for the Defence Services was considered. In late 1941 it was decided to accept certain brands of Hongkong and Japanese lanterns also. But with the entry of Japan into the war, imports of these lanterns were absolutely shut out. At the present moment the requirements of Defence Services are met mostly from indigenous sources. The following are the producers, and their productive capacity is also noted:—

Producers.	*Capacity.*
1. Oriental Metal Industries Ltd., Calcutta	30,000 per month
2. Ogale Glass works, Ogalwadi	24,000 ,,
3. Behar Lantern Factory, Dumraon	6,000 ,,

These are supplemented by the imports of Dietz lanterns from America. Shipments of these lanterns are usually frozen at the ports of discharge and requisitioned by Government.

The Supply Department has interested some other firms in the manufacture of these lanterns, but it is too early to say anything about their capability in this line. The Director of Munitions Production, Punjab, is also endeavouring to widen sources of supply for this particular store.

In peace-time the lanterns were required to be manufactured from tin-plate or blacksheet re-tinned. With the loss of Malaya the Government was forced to consider a substitute for tin. Accordingly it was decided to manufacture the lanterns partly from terne-plate and P.C. R.C.A. black plates (pickled, cold. rolled, closed, annealed black plates). It was subsequently decided that lanterns should be entirely made from P.C. R.C.A. black plates.

Every assistance is given to the three firms mentioned above in acquiring their materials at controlled rates, especially P.C. R.C.A. black plates, wire, nails, solder and brass sheets.

Before the war, the price of these lanterns was about Rs. 13-8-0 per dozen. To-day Ogale lanterns are sold in the market at about Rs. 54 a dozen. Therefore, it is considered that the chances of the industry surviving the war without Government's protection are few.

Pressure oil lamps.—Before the war, these lamps, generally of Petromax type, came from Germany and the major portion of civil and military requirements were met by the imports. Lamps from America and other Continental countries also used to put in their appearance in this country, but they did not have much sale. After the outbreak of war, the following firms in India took up production:—

1. Krudd Industries, Calcutta.
2. Esbee Engineering Works, Calcutta.
3. Dazzle Products, Calcutta.
4. C. S. Pochee & Sons, Calcutta.
5. Abbas & Co., Bombay.

They manufacture the following types of lamps :—

(1) Lanterns Hurricane and incandescent—100, 200. 300 candle power.
(2) Lamps incandescent hanging—400 candle power.

The indigenous products do not come up to the Petromax standard. All the components are not manufactured in India, and manufacturers have to depend on imports for certain Components, like pressure gauge. Owing to the scarcity of heat-proof gloves, it has been decided to accept mica chimneys conforming to particular standards. Indigenous capacity is far short of our requirements. Capacity for 200 candle power hanging lamps has not been established so far.

3. **Stoves (oil pressure).**—Before the war stoves came chiefly from Sweden. This industry has been built up during the war and its present outturn is quite sufficient to meet our requirements. The chief producers are the following, each having a daily output of 200 to 300 stoves :—

(1) Dazzle Products, Calcutta.
(2) F. Racck & Co., Calcutta.
(3) Bharat Store Co. Bombay.
(4) Silpha Peth., Calcutta.

4. ELECTRODES AND CARBIDE

4. **Electrodes.**—Electrodes are used for electric welding. They are pieces of steel wire coated with flux which on burning becomes slag.

Before the war, electrodes for electric welding were imported to the extent of about 500 tons a year. Since the war broke out the demand for electrodes has increased nearly four times the previous demands, *i.e.* about 2,000 tons a year. H.M.G. has lately given to India an allocation of electrodes from England, but the supply position does not allow of early transport. Delay in a welding job is most irksome. But by careful control and discrimination in acceding to indentor's requests for electrodes, most of the industries have been kept working. The requirements, however, are so great that several firms have recently set up plant locally. The chief among them are the following :

Indian Electrode Mfg. Co., Calcutta.
L. & H. Digrum, Calcutta.
National Radio Engineering Co., Bombay.
Guy Ward & Co., Bombay.
Western India Co. Jodhpur.
Australian Welding Co., Lahore.
International Arc Welding Electrode Co., Bombay.

In addition to these there are about 10 more firms making electrodes by hand, but it is anticipated that after the war only those firms making electrodes by machine methods will survive, since the quality of the hand-made stuff is not up to the mark, nor can their makers compete in speed of production The present demand is not likely to continue after the war and the output of these six firms will be sufficient to meet India's requirements in full of the general service and structural grade electrodes. Alloy steel for electrodes for special work will still have to be imported.

5. **Carbide.**—This is required for making acetelyne. Before the war, it was mainly imported from Norway, Canada and Japan. Now the only source is South Africa. One carbide plant has been set up in the Rampur State. It will be difficult to say now whether the indigenous production will continue after the war.

SECTION XI.—MISCELLANEOUS STORES

1. ABRASIVES

Owing to the substitution of grinding for many operations that were formerly machined, the importance of abrasives In the engineering world has greatly increased in recent years. This increase was, however, not so marked in India as in U.K., U.S.A. and other large industrial countries.

Even before the war, there was sufficient capacity in India for manufacturing abrasive papers and cloths, since the raw materials are all available here in one form or other. Apart from cottage industries all over the country, there

are now four large firms who have machineries for manufacturing these articles on a big scale. They are :—

K. L. Thirani, Calcutta, Strawboard Manufacturing Co., Punjab, National Sand Paper Mills, Punjab, and Ajax, Madras.

The raw materials required are paper, cloth, glue and abrading powders. The first three are available in the country. Difficulty occurs only in the matter of abrading powders. Of the many abrading powders in common use, the most important are the natural ones, like emery, sand, corundum and garnet. Before use in industry these natural abrasives have to be fastened to sheets or strips (*e.g.*, emery cloth) or embedded in a carrier (*e.g*, grinding wheels). There are artificial abrasives also like carborundum and aluminium oxide used for making grinding wheels and abrasive papers. There is a large variety of other abrasives including diamond powder, steel grit, pumice and rouge, but these are of little commercial importance. Carborundum (silicon carbide) is made by fusing coke and sand in an electric furnace, while artificial aluminious abrasives are usually made by fusing bauxite in a similar way. No artificial abrasives are made in India.

The abrading powder for sand paper and cloth is available here in abundance. Garnet sands are found in the Tinnevelly District of Madras. About 1,000 tons were produced here in 1914. The workings were then closed down until 1927. Production in 1934 came to 225 tons. Garnets are also available in Jaipure, Udaipur and Kishengarh States and in Ajmer-Merwara. India was also exporting garnets in small quantities to U.K.

But the abrading powder for emery paper and cloth, that is emery, although available in the country is of inferior quality and is not of much use. Until recently emery was the most commonly used abrading powder in the West. But now purer forms of corundum which have recently been discovered in quantity and artificial abrading powders which are tougher and freer cutting and hence have a longer life, have taken the place of emery.

Corundum or natural aluminium oxide has very good abrading quality as a substitute for emery. It is found in several parts in India, chiefly in the north-west Khasi hills, Assam. In many parts of India it is collected in a casual way by agriculturists and sold to dealers in town. It was mined and exported to U.K. during the last Great War, but its production ceased after 1921. In later years there has been some production in some parts of India, but manufacturers have reported that its supply in India is not available in abundance and that its use puts up the cost of production to such an extent that it makes it impossible for them to compete with imported stores. The average annual production from 1914 to 1918 was 26 tons, and no output has been recorded since then.

In the absence of a proper substitute in sufficient quantities, emery seems to be the only good abrasive and importation of emery powder from Turkey which is the supplier of this commodity to all other countries, is the only solution 'to the problem; If facilities for this can be arranged for, the whole of India's needs except for very special items, can be met by local manufacture, and there will be no necessity for importing emery paper and cloth even of the best quality. Arrangements have been made by Government for the private import of 300 tons of best Turkish emery ore which should go far to meet India's requirements of abrasives. At present imports worth about Rs. 10,00,000 (annually) are coming, and the indigenous production comes only to the value of Rs. 5,00,000.

2. Steel Furniture

Steel goods like almirahs, cupboards, steel shelfing and cabinets, storage racks and safes; ordinary and fireproof were being made in India before the war. The chief producers were the following :—

1. Godrej Boyce & Co., Bombay.
2. Alwyn Steel Works, Hyderabad.
3. Noble Steel Products, Calcutta.
4. Steel Products Ltd., Calcutta.
5. Bungo Steel Furniture Co., Calcutta.

Machinery is extensively used in the production of these articles, and is mainly imported. Raw materials are all indigenous, steel is the chief of them; some fireproof composition (made of chemicals) is also required and it is available from indigenous sources.

In war time there has been no addition of firms, but production has increased owing to great war demands. No accurate figures of production are available either for the pre-war period or for war-time. Government purchases which were negligible before the war compared to civilian demands, now take up about 50 to 60 percent of the output of the firms.

3. Pipes and Tubes.

Under this heading, we may deal with (1) hume pipes, (2) cast iron pipes and (3) steel tubes.

(1) **Hume Pipes.**—Hume Pipes are reinforced cement concrete pipes centrifugally spun by the Hume process. They are of two kinds, 'pressure' and 'non-pressure'. High Pressure hume steel pipes in diameters up to 48" are required for water supply. Such pipes are manufactured in shells from plates 1/8" to 1/4" thickness and outcoated with concrete or hessian and bitumen. Hume pipes are also used for culverts, irrigation and drainage, and for sundry uses such as urinals, latrines, septic tanks, dust bins, water storage tanks, etc. The raw-materials required for the manufacture of hume pipes are cement, steel plates and rods. Owing to shortage of steel, cast iron and other substitutes have been used.

The Indian Hume Pipe Co., is the chief, and till recently the only, company engaged in the production of hume pipes. Starting production in 1926, it soon expanded its business, and by 1941 it came to own 35 factories scattered all over India.

War brought a great demand for hume pipes, and in the first year itself, the supply Department ordered 300 miles length 8" hume steel pipes. This necessitated the installation of new plant, and the production capacity reached the figure of ½ mile length per day.

With the object of making the plant self-sufficient, the Company has put up an electric steel furnace and a rolling mill to produce wire and rods. They have got a well-equipped workshops, and almost all the machinery required in the pipe factory are manufactured by the firm in their workshops at Bombay and Jamshedpur. Hume pipes for the Karachi Water Supply Scheme were made by this Company and today they are making pipes for the hydro-electric scheme at Jogfalls.

The expansion of the work of the Indian Hume Pipe Co., can be seen from the great increase in the annual turnover of the firm.

Turnover of the Indian Hume Pipe Company

	Rs.
1926-27	67,503
1938-39	33,94,242
1942-43	68,00,000

The above table shows that the volume of business of the company has doubled in the war years.

One new firm—The Gujrat Sanitary Engineering Company, Ahmedabad—is also engaged in the production of hume pipes, but its capacity is very limited.

In the post-war period, there may be greater demand for hume pipes, and if steel and cement are available in adequate quantities, the production capacity of the Indian Hume Pipe Co., alone may be able to meet the whole demand.

(2) **Cast Iron Pipes.**—Like hume pipes, cast iron pipes are also of 'pressure' and 'non-pressure' kinds. The 'pressure pipes' are used for water drainage and sewage lines, and the 'non-pressure pipes' are used as rain water conveyances and also for soil and sanitary service. The durability of cast iron pipes is well known: it is claimed that they are impervious to corrosion and rust.

Production of non-pressure type is carried on by many firms all over India. But in the case of pressure pipes and fittings production is chiefly confined to three firms. They are:

(1) The Indian Iron and Steel Company, Kulti.
(2) The Mysore Iron and Steel Company, Bhadravati.
(3) The Tatanagar Foundry Ltd., Tatanagar.

Before the war, the total production capacity of the firms was about 13,500 tons a year. In war time cast iron pressure pipes are required in large numbers for the new water supply schemes which had to be undertaken as war emergency measures, and as substitute for steel pipes and other pressure pipes, which used to be imported from abroad. Cast iron pipes had also to be sent to the Middle East. As a result, the production increased, the annual output exceeding 40,000 tons, *i.e.*, more than three times the pre-war figures. Even than the supply was insufficient, and to ease the situation the Indian Iron and Steel Company decided to instal a 'spun pipe' plant, with an annual capacity of about 25,000 tons. With Government's help arrangements have been made for the import of the necessary plant and machinery, and production as expected to begin next year. To increase the supply, it was also proposed that the various small firms be asked to produce cast iron pipes on a cottage industry basis. But this would have been costly, not to speak of the difficulty of transporting the raw materials and coal to the scattered producers. However, the supply position improved in 1944 with the ceasing of demands from the middle East and the arrival of steel pipes and fittings from U. S. A. under Lease/Lend arrangements. Chief among the many small firms who manufacture cast iron pipes of pressure and non-pressure types, (1) Port Engineering, (2) Sayaji iron Works and (3) Mukand Iron and Steel Works (Bombay) These firms manufacture small quantities for supply to private indentors.

(8) **Steel Tubes.**—Steel tubes are used for house water connections and for the conduct of gas and steam and other liquids and gases. They are eseential for tube wells, which are common throughout India. They are also used for light constructional purpose.

Steel tubes were made in India before the war by the Indian Tube Company Ltd., Calcutta, but their production came to only about 3,000 tons as against a total consumption of about 30,000 tons. Their factory is situated at Shalimar near Calcutta. Steel strip for the industry came from abroad. Later the Company entered into an agreement with the Tata Iron and Steel Works, and Stewart Lloyds whereby Tatas were to produce the necessary steel and new and larger Tube Works was to be set up at Jamshedpur, which would be capable of supplying about twice the pre-war Indian demand. Arrangements were completed in 1939 for the new tube works, but the Government decided that Tatas should not take up the new project immediately.

Shortly after the war started, the Indian Tube Company had to close their plant, but it was re-opened in 1940, at Government's rquest. Their production figures till 1943 came to 10,000 tons of tubes. Now the factory has again been closed down owing to the U.S.A. authorities preferring to supply finished tubes rather than strip against Lease/Lend arrangements. All these tubes were taken up by the Engineer-in-Chief and the G.H.Q. The new plant at Jamshedpur when, it begins production may be able to compete successfully with imports at fair prices.

4. Scientific Instruments

The term 'Scientific Instruments' and 'Apparatus' covers many instruments used by industrial concerns, laboratories colleges, hospitals etc. Their production calls for a very high standard of artisan craftmanship which can only be developed after years, and in some cases generations of practice. The industry requires a wide variety of raw materials, but excepting castings they are mostly non-ferrous and are obtained from abroad.

Before the war, there was no production in India of instruments and apparatus of a highly specialised character. A number of firms were producing

simple instruments and apparatus, but even they were not on a mass production basis. According to one estimate, the indigenous production in all met only 5 per cent. of the total annual consumption of India.

The war has brought about the adaptation of a number of maintenance workshops and the establishment of a few purely manufacturing workshops, manufacturing scientific stores for the Defence Services. These are mainly on the lines of Fire Direction and Control, and associated stores, for artlilary, surveying and drawing instruments, a certain amount of signalling equipment, etc. In addition to the trade types produced before the war some of the firms have developed the manufacture of a number of simple instruments and apparatus also. This was possible because of the stoppage of imports of these articles. Some of these firms are attempting to make more difficult instruments also. The production of laboratory glassware which is a direct ancillary to the production of scientific instruments and apparatus has also expanded considerably in India in war time. The section on Glassware in the D.G.S. report gives fuller details on this item.

The position of the industry after the war is uncertain. The present production is not a large financial proposition, and the total annual consumption of instruments and apparatus does not exceed a few tens of lakhs of rupees in value. But in the wake of the policy of industrilisation in the post-war period, industrial research and scientific control of manufacture will require a large number of instruments and apparatus which could be produced in India, if the production is properly organised and rationalized.

The first thing to do in rationalizing the industry is the standardisation of the types of instruments produced and used in India. For this a Bureau of Physical Standards, similar to the National Physical Laboratory at Teddington, England, or the Federal Standards Bureau in U.S.A. must be set up to guide the production of firms in order that they may not indiscriminately try to produce any and every type of instruments and apparatus. The users of these instruments and apparatus in India, trained in the educational institutions in different countries exhibit a prejudice in favour of the particular instruments and apparatus to which they are used. They must be guided in their choice of instruments and be persuaded to stick to standardised goods of Indian make. For, the manufacture of these stores can become profitable only when large quantities are produced and this is possible only if the consumers' needs are standardised and production is confined to the standardised types. The rationalization of the industry will also call for the liquidation of many small and inefficient firms now working.

If Indian production is rationalized on these lines, India will be able to dispense with imports at least for the simpler types of instruments and apparatus. But in the matter of more complicated ones, imports may be necessary at least for sometime to come. (See Appendix II.)

QUESTIONNAIRE

(Used for the present Report)

1. State whether the industry was newly started as a result of the war, or is only an expansion.
2. The nature of the articles produced and their various uses.
3. Raw materials or components used; state whether indigenous or imported.
4. Total production :—

	Total		Govt. Purchases	
	Quantity	Value	Quantity	Value
(a) Before the war				
(b) 1942				
(c) 1943				
(d) 1944 (estimated)				

5. The chief producers : (a) Before the war.
   (b) New additions.
   (State also the quantities produced in 1943 by the chief producing units)
6. Production process : if machinery is used, is it imported or made in India ?
7. Assistance rendered by Government ; nature of control, if any.
8. If production has increased in war-time, was it due to the diminution of imports, or to abnormal war demand ?
   How was the new demand met, By working more shifts on old plant, or by laying out new plant ? If the latter, how were the plants obtained ?
   How was the skilled labour found ?
9. If the industry was started in war-time how did the need arise ?
   How was the plant obtained and skilled labour found ?
10. Is the new production, whether under 8 or 9, such as can meet peace-time requirements ? If adjustment will be required, state its nature briefly.
11. Is the new production likely to be able to compete successfully with imports in the open market after the war ? If not why ? Can it claim any special treatment ?

APPENDICES

(Containing information obtained after the Report went to the press)

APPENDIX I.

ALUMINIUM.

The Aluminium Corporation of India Ltd., was started just before the outbreak of war, and contracts were made with the Skoda Works of Czechoslovakia for the plant and machinery at very low prices. But war intervened and only about half the plant could be obtained. Meanwhile the company changed hands and now it is owned by Singhania Brothers and managed by the J.K. Industries, Cawnpore. The additional plant required was subsequently obtained and installed with the priority assistance of the Government of India. A greater difficulty was the lack of experienced technical personnel. This was also overcome when the Government of India brought over a team of technicians from Canada in 1943. This team remained in India for several months and was of great assistance in organising the factory which is situated at Anupnagar, near Asansol, in Bengal.

The factory has three main parts :

(1) The Alumina plant, which extracts alumina by Bayer process from raw bauxite obtained from Bihar ; (2) The smelter consisting of a cell house, where anhydrous alumina is reduced electrolytically in Sodeberg type furnaces to pure aluminium metal ; and (3) The Paste plant where petroleum coke is converted into paste for use in the Sodeberg anodes of the reduction furnaces.

Close by are the colliery, and the power station which supplies electric power and steam for use in the factory and the colliery. The Company is putting up a rolling mill which will be available by the middle of 1945 for the production of sheet. Plans are also being laid for the establishment of an aluminium utensil factory.

The Aluminium factory has now a capacity of about 3,000 tons of aluminium ingot per annum. To produce this, 12,000 tons of bauxite and about 100,000 tons of coal for use in the power station are required. By August 1944, the factory has produced several hundred tons of alumina of fair quality and 20 to 30 tons of aluminium ingot, even though the Company is woking under many war-time handicaps, not the least of them being the acute shortage of coal used by the inadequate pumping equipment and haulage in the colliery and the seasonal departure of the colliery labour.

APPENDIX II.

Scientific Instruments.

Pre-war —The following firms were the chief producers of simple types of scientific stores and drawing instruments in India before the war :—

1. P. Orr & Sons, Madras.
2. Lawrence & Mayo, Bombay.
3. Balance Works, Benares.
4. National Emporium, Roorkee.

Many other firms also claimed to be suppliers of scientific instruments and stores, but investigations made at the time of the Eastern Group Conference in 1940 showed that they were only importing firms,

Apart from the trade firms mentioned above, the main pre-war source of supply in India, for scientific instruments and stores was the Mathematical Instruments Office (M. I. O), Calcutta. This is a Government factory under the Department of Education, Health and Lands employed mainly on the production and repair of scientific instruments for the Survey of India. Orders were also carried out for other Government Departments including Railways, Forest Service, Excise Department, Public Works Department, etc. This one factory probably produced more scientific instruments and stores than all the trade sources put together, excluding, of course, imported supplies slod by trade organisations.

War-Time.—About 160 firms are now producing scientific instruments and stores in India. But very few of them are equipped or competent for the manufacture of complete scientific instruments. The following firms are the chief among these few firms :—

1. Associated Instrument Manufacturers Ltd., Calcutta.
2. Associated Instrument Manufacturers Ltd., Lahore.
3. Crescent Manufacturing Company, Lahore.
4. Lawrence & Mayo (India) Ltd., Bombay.
5. National Emporium, Roorkee.
6. P. Orr & Sons, Madras.
7. Scientific Apparatus Chemical Works Ltd., Agra.

The remaining firms, over 150 in number should be regarded merely as sub-contractors for the production of small machined components

The Mathematical Instruments Office has been enlarged and converted into an Ordinance factory, and the work of manufacturing simple stores like drawing boards, stands, instruments, sun compasses, etc., has been taken away from M. I. O and given to the private firms. This has left M. I. O. free to concentrate on the production of the more important stores such as binoculars, prismatic compasses, sighting telescopes, etc.

Of the total of about 160 firms engaged in this industry, 100 are in Bengal (95 in Calcutta), 21 in Lahore, 4 in Lucknow, 15 in other parts of North India. 8 in Bombay, 5 in Madras, and 1 in Bangalore. The concentration of the industry in and around Calcutta is not quite advantageous, as Calcutta's climate is not suitable for optical work, but this difficulty can be overcome by air-conditioning the factories.

Post-War.—Practically the whole of the stores manufoctured under the war-expansion scheme are for war purposes and are not likely to be in demand after the war, either in India or in the overseas, markets. But about 30 percent to 50 percent. of the capacity now employed might be utilised for the manufacture of other type of scientific stores suitable for civil markets. If these can be produced at marketable rates, a good proportion of the technical personnel now employed can be retained in the industry after the war; if not they can be absorbed in other similar Industries such as the manufacture of bicycles, sewing machines, gramophones, clocks, watches, etc. The cessation or partial cessation of war-time instrument industry would not give rise to any serious unemployment problem, as the total numbers now employed are not more than a few thousands. Whether more technical personnel are required depends on what the Indian manufacturers decide to produce; for example, if it is decided to produce cameras or sound film projectors, experts in the production of such apparatus will be required.

10 MAR 1948

CENTRAL NATIONAL MUSEUM

OF

ART, ARCHAEOLOGY AND ANTHROPOLOGY

(REPORT OF THE GWYER COMMITTEE)

108848

NEW DELHI: PRINTED BY THE MANAGER
GOVERNMENT OF INDIA PRESS: 1946

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CENTRAL NATIONAL MUSEUM
OF
ART, ARCHAEOLOGY AND ANTHROPOLOGY

REPORT OF THE GWYER COMMITTEE

I. TERMS OF REFERENCE

1. In the Inter-departmental meeting of the 10th September 1945 the scheme for the establishment of a Central National Museum of Art, Archaeology and Anthropology was accepted in principle. Thereafter Government decided to appoint a small committee to frame the details for the establishment of such a museum with special regard to :—

(1) The functions (powers, etc.) of the Museum.
(2) Its general administration.
(3) Its internal organization.
(4) Its site.
(5) Its building (including the possibility of progressive construction).

II. COMPOSITION OF THE COMMITTEE

1. Sir Maurice Gwyer, K.C.B., K.C.S.I., *Chairman.*
2. Sir John Sargent, C.I.E.
3. Mr. H. A. N. Medd, F.R.I.B.A.
4. Mr. V. Narahari Rao, C.I.E.
5. Mr. H. V. R. Iyengar, C.I.E., I.C.S.
6. Mr. G. S. Bozman, C. S.I., C.I.E., I.C.S.
7. Dr. R. E. Mortimer Wheeler, M.C.
8. Dr. S. N. Sen.
9. Dr. B. S. Guha.
10. Dr. D. M. Sen.
11. Dr. N. P. Chakravarti, O.B.E., Secretary.

III. MEETINGS

3. The Committee met at Simla on the 13th and 14th of May, 1946. The Finance Department was represented by Mr. A. S. Lall, I.C.S., in place of Mr. Narahari Rao. Mr. Iyengar was unable to be present but has approved the Report.

PART I—THE SCHEME AS A WHOLE

IV. SCOPE OF THE MUSEUM

4. The Committee is of opinion that the museum should comprise a Directorate and five Departments, namely : 1. Art. 2. Prehistoric Archaeology. 3. Historic Archaeology (Buddhist, Jaina, Brahmanical, Muslim). 4. Numismatics and Epigraphy. 5. Anthropology (Cultural and Physical). There should also be a Circulating Department, a Library and a Chemical Laboratory.

5. The *Directorate* should consist of a Director and an Assistant Director, whose duties would include publicity and liaison, a Secretary, a highly qualified Librarian, and a Superintendent of Publications. It should also include a guide-lecturer for each of the five main Departments. (For details see Appendix A).

6. The Director must be a scholar with special knowledge of one or more branches of the Museum's work, and with approved experience of museum administration. Upon his energy and enterprise the utility and reputation of the Museum will mainly depend.

7. Special attention is drawn to the importance of the Librarian in this scheme. The Library, though not generally open to the public, would be available not only to the Museum staff but also to approved research students and scholars, whom the Librarian must be fully competent to guide in regard to published material in all branches of the Museum's work. He must therefore himself be a man of wide learning, as well as a trained library technician. It may be recorded that the most successful Director of the British Museum in recent times was previously its Chief Librarian.

8. The guide-lecturers will represent an important function of the Museum as a popular educational institution. Experience in other countries has shown the outstanding value of a regular series of good popular lectures, both for schools and for the general public. The Departmental staffs will also be expected to lecture as occasion requires.

9. *Departments.*—The staffs of the various Departments are set forth in Appendix A. Their organization should, so far as possible, be uniform, and the details in the Appendix are based on similar departments in other national museums.

10. The function of the Art Department should be to represent Indian pictorial and sculptural art (including illuminated manuscripts) from the earliest periods until recent times, including examples of the higher craftsmanship of artistic value, but would not include either modern Indian art or the art of countries remote from India or unrelated to traditional Indian cultures. It is assumed by the Committee that a National Gallery of Art will eventually be established and will cover this wider range.

11. Attention is drawn to the potential value of a Circulating Department which, by preparing and sending out classified loan collections to towns and educational institutions throughout India, can fill a long-felt eductional need The model taken for this Department is the Circulating Department of the Victoria and Albert Museum, London, which for many years has played an important part in the educational life of the United Kingdom.

V. HIGHER ADMINISTRATION

12. On the analogy of other institutions of the kind, it is recommended that the Museum should be controlled by a Governing Body operating mainly through a Committee of Management. In additon, it may be found desirable to have small Departmental Advisory Committees of experts.

13. The *Governing Body* should include representatives of appropriate Government Departments together with non-officials representing various special interests. Its powers and functions should be as follows :—

(1) In accordance with the successful precedent of the British Museum it should be autonomous subject to such conditions as the Government of India may attach to their block-grant (see below, paragraph 17).

(2) It should review and approve the budget prepared by the Committee of Management and submit it to the Government of India, but would not normally deal with administration nor with the detailed allocation of the block-grant.

(3) It should receive and publish the annual report submitted to it by the Committee of Management.

(4) It should appoint the Director, but not the other officers, through an *ad hoc* committee of its members sitting with a representative of the Federal Public Service Commission.

(5) It should as need arises instruct the Committee of Management in matters relating to general policy.

(6) It should act generally as a link between the Museum and official and public interests.

It should consist of :

1. Nominees of the Central Government (Education Department, Finance Department, Department of Information and Art, Heads of three appropriate Surveys, Government Architect, Director of Archives)	7
2. Nominees of the Central Legislature	8
3. Nominees of Provinces (one each)	11
4. Nominees of States	7
5. Nominees of universities	5
6. Nominees of learned societies and institutions	7
7. Individuals nominated by the Government	10
Total ...	55

The Chairman would be nominated by the Governor General from the members of the Governing Body. Normally members would be elected or appointed for three years and would be eligible for re-election or re-appointment for not more than one further consecutive term. In order, however, to avoid an excessive change of personnel at the end of the first three years, one third of the members initially elected or appointed would retire at the end of the first year and one third of the remainder at the end of the second year, the method of retirement to be determined by the Governing Body.

14. The *Committee of Management* should consist of:

1. The Director of the Museum, ex-officio.

2. One representative from each of the seven categories composing the Governing Body, to be elected by that Body.

The representative of the Central Government should be its Chairman. Keepers of the Museum Departments would be in attendance at its meetings but would not vote.

The functions of the Committee of Management should include:

(*a*) The general management of the Museum, subject to the specific powers reserved to the Governing Body.

(*b*) The preparation of the annual budget.

(*c*) The allocation of the Government grant, and the readjustment of expenditure from time to time as may be deemed necessary.

(*d*) The formulation of policy, subject to the general approval of the Governing Body.

(*e*) The appointment of the gazetted officers of the Museum other than the Director, acting normally through an *ad hoc* Appointments Committee of its own members sitting with a representative of the Federal Public Service Commission. It should have the power of varying the initial pay of officers within the minimum and maximum limits laid down. It should be entitled, when absolutely necessary, to exceed the normal maximum but would be required promptly to report such action to Government.

(*f*) The preparation of an annual report for presentation to the Governing Body.

The Committee of Management would meet as required but in any event not less than three times a year. The availability of its members would therefore be considered by the Governing Body in their selection.

15. If the Governing Body should decide that *Departmental Advisory Committees* are desirable, these would be appointed by the Director in consultation with the appropriate Keeper or Keepers. They would normally consist of specialists in the work of the Department or Departments concerned.

16. Except in so far as the Surveys are represented on the Governing Body (paragraph 13), the Museum should be administratively independent of them. The main bulk of the Departmental libraries of the Archaeological and Anthropological Surveys should, however, be amalgamated as soon as possible with the Museum library, which would be fully available to the staffs of the Surveys. Furthermore, it is assumed that the Museum and the Surveys would co-operate closely with one another, the latter acting in some measure as collecting agencies of material and information for the former. It would be found useful in practice from time to time to second officers of the Museum to the Surveys for limited periods for training and experience in fieldwork.

VI. FINANCE

17. Certain aspects of Finance have been dealt with above. The essential principle should be that an annual budget prepared by the Committee of Management and approved by the Governing Body is submitted to Government, and on the basis of this budget Government would make a block grant. With the budget, or before its submission, the audited accounts for the previous financial year should be submitted through the same channels for scrutiny. Unless special circumstances arise, however, the Government of India would not control the detailed allocation of the block-grant; this should be at the discretion of the Governing Body through the Committee of Management. It is to be expected, however, that an explanation would be required by Government of any substantial deviation from the allocations anticipated in the appropriate budget.

18. The budget should normally include provision for :

(*a*) *The staff.*

(*b*) *A purchase fund.* This should be cumulative and of moderate size—one lakh per annum is suggested. This small grant would not enable the Museum to acquire important collections, but it is recommended that when an exceptional collection comes into the market application for a special additional grant should be made through the proper channels. In an emergency, the Director should have power to make such an application immediately to Government without reference to the Committee of Management or the Governing Body, but, in that event, a full report would of course be rendered to them at the earliest opportunity.

(c) *Travelling allowance.* A liberal provision for *travelling* is essential to enable the staff (particularly but not exclusively of the Department of Anthropology) to contact material at source. It would also be required in connection with the Circulating Department, for lecturing, and for general liaison. Furthermore, it is essential to include provision for sending officers overseas on carefully planned tours so that they may familiarise themselves with the administration of first-class museums in other parts of the world. It is anticipated that for this purpose one officer would be sent abroad each year.

(d) A *contingencies fund* is essential for the normal working of the institution. It would cover petty expenditure, together with such items as the purchase of library-books, the preparation and transmission of specimens, the fitting up of show-cases, dioramas, etc. A total sum of one lakh of rupees is estimated as the minimum necessary for these purposes.

VII. SITE

19. Various sites have from time to time been suggested for the Central National Museum but since the preparation of the original lay-out of New Delhi the site officially allocated has been at the Kingsway-Queensway crossing. After considering various alternatives, the Committee is of opinion that this site offers the best practical prospects.

The site in question was planned to contain four buildings, each of them flanked by the two main thoroughfares, and it is recommended that one of these building sites be allocated to the Museum. The Committee expressed the hope that the frontage of these buildings can be set back sufficiently to avoid intrusion upon the Kingsway vista.

20. In advocating this site the Committee has in view the potentialities of the adjacent sites. In particular, it is emphasised that any building allocated to the Central Surveys should be as close as possible to the Museum. Only so would it be feasible to maintain the close collaboration between the Museum and the Surveys that is essential to both, and only so would it be possible for the Archaeological and Anthropological Surveys to pool certain of their resources (notably their libraries) with the Museum. If it were found possible to include the Record Office and the proposed National Library building in the scheme, a further great advantage would accrue.

VIII. BUILDING

21. The external design of a building in the prominent position indicated is a matter of general policy, having regard to the architectural development of New Delhi as a whole, and lies outside the scope of this committee. It

may, however, be recorded that the most suitable plan for a museum is one that approximates in outline to a square, thus facilitating centralised control and maintenance of contact between related Departments. As regards internal design, one or more courtyards are essential. A total minimum space of 80,000 square feet would be required for exhibition, and at least 30,000 square feet for offices, laboratory, library and reserve-collections. A basement-floor of not less than 25,000 square feet would be necessary for storage. These figures are based upon a modern national museum in the U. K.

22. Although the ways and means of procuring a suitable architectural design scarcely come within the scope of this committee it is suggested that, in view of the special experience required by the architect of a large museum. the advice of the Royal Institute of British Architects be sought in this matter It will probably be found desirable to select, on advice, a suitable architect who could work subsequently in close collaboration both with the Museum Director and with the Government Architect. In any case, the Museum Director must from the outset be consulted constantly in regard to the general plan and to its detailed development.

23. It is not possible for this Committee, on the information available to estimate the capital cost of a building of this kind with its equipment. It may be recorded, however, that the National Museum of Wales, the youngest of the national museums in the United Kingdom—a building which is the product of wide experience and research and is generally recognised as architecturally the most successful museum building in that country—was brought to a state of three-guarter completion before the war and had up till that time cost approximately £ 500,000 sterling.

PART II—THE SCHEME BY STAGES

24. The process of building and equipping a new museum on the scale indicated will necessarily be a fairly long one, and from the point of view both of administration and of finance the committee has envisaged three main stages in its growth, the first stage being itself sub-divided into two phases. On this principle, with the collaboration of the architect it would be possible to get portions of the new building into active use progressively without waiting for the completion of the whole structure. Here again the analogy of the National Museum of Wales is relevant. That museum has been brought into use almost room by room during the actual process of building.

25. In detail, the three stages are as follows :—

Stage I—Phase I. The first essential is to select the Director and a nucleus staff for purposes of training. The appointment of this nucleus staff is pivotal

for the whole scheme, and the Committee is impressed with the necessity in this instance of anticipating the function of the Governing Body and its Management Committee, which would not themselves be in a position to function adequately without some form of central administration. Furthermore, the whole progress of the scheme is contingent upon constant supervision and direction by a trained nucleus staff. The necessary training and experience involve a carefully planned foreign tour which should include a detailed examination of the construction, administration, methods of display, etc., of certain of the best museums of Great Britain and America. It is accordingly recommended that, in addition to the Director, two Keepers representing respectively archaeology and anthropology should be appointed immediately and that these three officers should proceed overseas forthwith on a planned tour arranged by the Government of India.

26. The qualifications of the two Keepers, as of the Director (see above paragraph 6), must be of a high order. They must include suitable experience of museum-administration, together with a scholarly knowledge of some branch of the Museum's Departmental work. Of the three officers named, one should represent Anthropology and one should , if possible, be a Muslim.

27. The total annual cost of this phase is estimated at Rs. 2,25,880.

28. *Stage 1—Phase II* would include the remainder of the Directorate as set out in Appendix A, together with the Departments of Art, Historic Archaeology, and Anthropology (Cultural Section) , together with the Museum Chemist's Department. The Department of Art is selected as representing some of the finest manifestations of Indian culture and as deserving, therefore, a high priority ; whilst the Department of Historic Archaeology, dealing as it does with much of the material from which the Department of Art must make a selection would appropriately develop simultaneously with it. The Cultural Section of the Anthropological Department is included at this stage for the reason that at the present time much cultural material of value—particularly in respect of local arts and crafts—is rapidly disappearing and its salvage is a matter of urgency. The Museum Chemist's Department is essential from the outset if the materials collected are to receive essential attention, which cannot be deferred without loss.

Stage II. At this stage the increasingly extensive prehistoric archaeology of India would be included in the Museum, and the Department of Anthropology would be completed by the addition of its Physical Section.

Stage III. To this stage have been allocated the Department of Numismatics and Epigraphy and the Circulating Department. The former is already partially covered by the Epigraphical Branch of the Archaeological Survey of India and is therefore less urgent than other Departments.

The Circulating Department would eventually form one of the most important branches of the Museum, but it will function most readily when the greater part of the Museum has been organized and when the availability of surplus material is better known.

(Signed) Maurice Gwyer (*Chairman*)

John Sargent	H. A. N. Medd	A. S. Lall
B. S. Bozman	R. E. Mortimer Wheeler	S. N. Sen
B. S. Guha	D. M. Sen	H. V. R. Iyengar

N. P. Chakravarti (*Secretary*)

APPENDIX A

ANNUAL EXPENDITURE

I. *SUMMARY OF ESTIMATED TOTAL ANNUAL EXPENDITURE*

A. *Staff*—

H.Q.	1,52,400
4 Departments of Art & Archaeology (each 53,220)	2,12,880
Department of Cultural and Physical Anthropology	1,13,124
Circulating Department	48,120
Museum Chemist's Department	21,720
	5,48,244
B. *Purchase Fund* (accumulative)	1,00,000
C. *Travelling allowance*	1,00,000
D. *Contingencies*	1,00,000
GRAND TOTAL	8,48,244

II. *DETAILS OF ESTIMATED TOTAL ANNUAL EXPENDITURE*

A. *Staff*—A total annual expenditure of Rs. 5,48,244 is estimated in respect of staff, distributed as follows :—

HEADQUARTERS STAFF

GAZETTED

(Central Services, Class I)

1 Director		1,750—100—2,250
1 Assistant Director		1,250—50—1,750
1 Secretary		750—50—1,200
1 Librarian		750—50—1,200
1 Superintendent of Publications		750—50—1,200

(Central Services, Class II)

1 Assistant Librarian		400—25—600
5 Guide-lecturers	(each)	400—25—600
1 Office Superintendent		400—20—500

NON-GAZETTED

(3 Stenographers, 2 library assistants, 5 clerks, accountant, cashier, 2 assistants, 3 carpenters, inferior staff)—approximately	2,825
Total H.Q. staff (average monthly expenditure)	12,700

DEPARTMENTAL STAFFS, ART & ARCHAEOLOGY (4)

GAZETTED

(Central Services, Class I)

1 Keeper		1,000—50—1,500
1 Deputy Keeper		600—40—800
2 Assistant Keepers	(each)	250—25—600

NON-GAZETTED

2 Clerks, stenographer, photographer, draftsman, 2 marksmen, 2 gallery assistants, storekeeper, and inferior staff —approximately	1,635
Total Departmental staff (average monthly expenditure)	4,435

DEPARTMENT OF ANTHROPOLOGY (CULTURAL & PHYSICAL)

GAZETTED

(Central Services, Class I)

1 Keeper	1,000—50—1,500
2 Deputy Keepers (one for physical and one for cultural anthropology)	600—40—800
1 Assistant Keeper (physical anthropology)	250—25—600
5 Assistant Keepers (respectively for Northern, North-Eastern, Central, Southern and Greater Indian Cultures) (each)	250—25—600

(Central Services, Class II)

Preparators: 2 for cultural and 1 for physical anthropology	250—25—400

NON-GAZETTED

Stenographer, 2 assistant preparators, artist, taxidermist, laboratory assistant, 2 chemical assistants, 4 gallery assistants, head clerk, second clerk, modeller, photographer, 2 marksmen, storekeeper, and inferior staff —approximately	3,252
Total Departmental staff (average monthly expenditure)	9,427

CIRCULATING DEPARTMENT

GAZETTED

(Central Services, Class I)

1 Keeper	1,000—50—1,500
1 Deputy Keeper	600—40—800
1 Assistant Keeper	250—25—600

NON-GAZETTED

Stenographer, 2 clerks, photographer, draftsman, 2 marksmen, 2 gallery assistants, storekeeper, and inferior staff—approximately—	1,635
Total Departmental staff (average monthly expenditure)	4,010

MUSEUM CHEMIST'S LABORATORY

GAZETTED

(Central Services, Class I)

1 Museum Chemist	600—50—1,000
1 Assistant Museum Chemist	300—25—600

NON-GAZETTED

Chemical assistant, laboratory assistant, 2 clerks, and inferior staff —approximately	560
Total Departmental staff (average monthly expenditure)	1,810

B.—Purchase Fund: A sum of Rs. 1,00,000 is estimated as a suitable basic purchase fund. This will be cumulative, *i.e.*, the balance (if any) will not be surrendered at the end of the financial year. Whilst adequate for normal acquisitions, this sum is not designed to meet exceptional purchases, for which special application will be made to Government as occasion arises.

C.—Travelling allowance: Rs 1,00,000 is estimated as a reasonable sum for the purposes of the collection of material, the inspection of collections and for external lecturing and general liaison.

D.—Contingencies: Rs. 1,00,000 is estimated as a minimum sum or (*a*) the purchase of books, (*b*) the preparation and transport of specimens etc., and (*c*) other normal expenses.

III. *RECURRING ANNUAL COST IN THREE STAGES*

Stage 1. Phase I (*a*) Nucleus Directorate	65,880
(Director, 2 keepers, stenographer— assistant, accountant, 2 clerks and inferior staff)	
(*b*) Purchase Fund	100,000
(*c*) Travelling allowance	50,000
(*d*) Contingencies	10,000
Total .	2,25,880
Phase II (Additional items)—	
(*a*) Remainder of Directorate	1,28,400
(*b*) Department of Art	38,220
(*c*) Department of Historic Archaeology	26,340
(*d*) Department of Anthropology, Cultural Section . . .	90,000
(*e*) Museum Chemist's Laboratory	21,720
(*f*) Contingencies	65,000
Total additional expenditure .	3,69,680
Stage 2 (Additional items)—	
(*a*) Department of Prehistoric Archaeology	53,220
(*b*) Department of Anthropology, Physical Section . . .	23,124
(*c*) Increased travelling allowance	25,000
Total additional expenditure .	1,01,344
Stage 3 (Additional items)—	
(*a*) Department of Numismatics and Epigraphy	53,220
(*b*) Circulating Department.	48,120
(*c*) Increased travelling allowance	25,000
(*d*) Increased contingencies	25,000
Total additional expenditure .	1,51,340
GRAND TOTAL .	8,48,244

APPENDIX B

Note on the site by the Chief Architect, Government of India

(Plan omitted from printed copy)

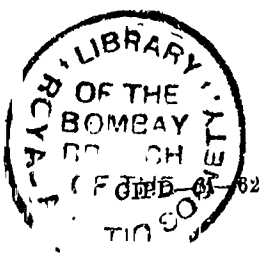
On the plan are shown, marked A, B, C, and D, the four buildings at the Kingsway-Queensway crossing as they were proposed in the original plan for New Delhi.

The present Record Office occupies a part of the site of A, but as built it does not represent a portion of A as originally intended.

It has been found that the Record Office as built is not well suited to its purpose, nor is its design suited to the purposes of a Museum, and should not be taken as a model for the design of the building which will occupy this or any other of the three sites. It is therefore proposed that it should be dismantled and that the building which takes its place, whether Museum or Record Office, should be designed more closely to suit its purpose.

In planning these four buildings it is not the intention that they should necessarily conform in their extent or their position with the original proposal as shown on the plan, since there may well be other solutions conforming with the overall needs of siting four large buildings at this important junction which will better suit the requirements than that hitherto proposed.

The four groups of buildings marked A′, B′, C,′ and D′, are not intended as appendages of A, B, C, and D but have been independently proposed as possible additional Government offices should the need arise in the more distant future. Whether the need for them does or does not arise their omission would not prejudice the planning of the four independent buildings A, B, C, and D. Any extension of the Museum activities, the building of a new Record Office, the housing of the Surveys, or the building of a National Library or Art Gallery should be met by the completion of A, B, C, and D before any expansion over A′ B′, C′, or D′ is considered, since the former comprise a unit in themselves capable of standing in isolation.



62 DG of Arch—6-8-46—500

INTRODUCTION.

The object of this short paper is to invite the attention and arouse the interest of Engineers to a very useful development in steel metallurgy, of recent growth, namely "Grain-size control in steel", which originated in the United States of America and is now actively pursued all over the world particularly in America and the United Kingdom. A voluminous literature has been compiled on the subject by various scientific bodies. It is hoped that this summarised survey on "Grain-size control in steel" will briefly present the essential data on the subject to the Engineers without their having to resort to a comprehensive and detailed study of this field of steel Metallurgy—often a discouraging task to non-metallurgists.

It is further hoped that a study of the data will initiate the applications of the developments in "Controlled grain-size" to various types of Indian steels both by the steel makers and users in this country.

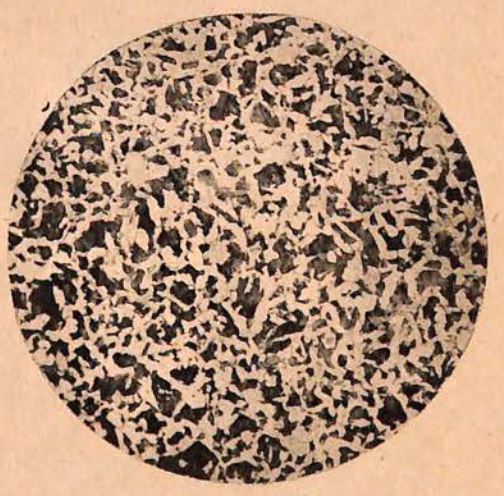


FIG. 1.—Normal structure of low Carbon Steel.

Magnification 100 Dia.

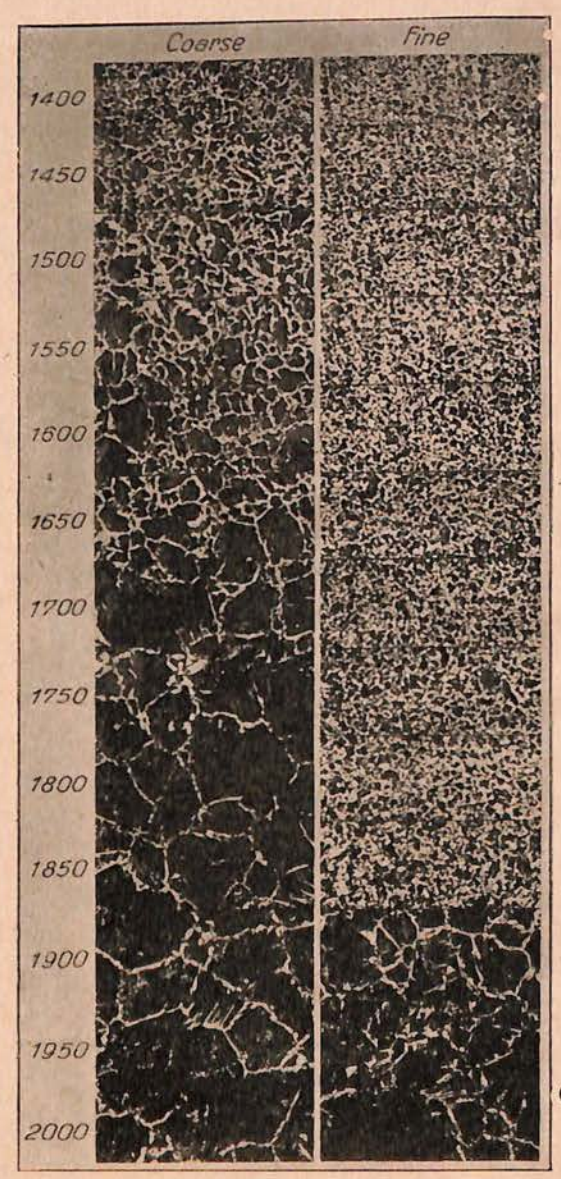


FIG. 2. Composite Micrographs showing the actual grain sizes of the Coarse and Fine-grained types after normalizing at Temperature shown in degrees Fahrenheit. (P. Schane Jr.)

"THE ENGINEER AND GRAIN-SIZE CONTROL IN STEEL."

What is Grain Size?

As is generally known, a mass of metal is made up of "Crystalline aggregates" or Crystalline Grains" or Simply Grains. In a general way, the three dimensional size of these metal grains affects the metal's behaviour to heat-treatment, its properties and service performance. When a steel ingot is cast the metal solidifies in a certain grain or dendritic pattern depending upon the size, shape and nature of the mould, the rate and the temperature of pouring, the fluidity of the metal etc. This original cast or dendritic grain pattern is then altered into the rolled, forged or pressed grain structure resulting from hot-soaking and mechanical work. The rolled or mechanically worked grain-structure is, in most cases, re-oriented into its normal distortion-free pattern through high temperature treatments termed "Normalizing" or "Annealing" which also tend to relieve the metal of any residual mechanical stresses. This finished grain-structure is thus ready to go into service. A typical example of mild steel in this normal condition is shown in Fig. 1.

Besides this grain-structure, there is another high temperature grain size of steel which is termed "Inherent Austenitic grain size" or simply "Inherent grain size". For plain carbon steels there is a temperature range between about 720° C. to 880-890° C. which is called its "Critical temperature range". When heated to this "Critical range", the steel undergoes an allotropic modification from what is termed as α type-Ferrite to γ type-Austenite and vice-versa from Austenite to Ferrite on cooling through the 'Critical range". In heating through this range, the metallic grains get rid of their mechanical distortion and tend to change into their normal structure or in short re-orient themselves into normal grains. Besides, certain changes in the solubility of carbon or iron-carbide (the form in which the carbon exists in steel) take place during its passage through the critical range. Just below the critical range the carbon is in solution in α ferrite to only about 0·04% and the rest of it exists in loose pearl like form, termed in metallographic language as "Pearlite". As the steel passes through the critical range more and more of the Pearlitic carbon is absorbed into the iron and finally, above the critical range, the carbon is wholly in solution in γ iron to form the Austenite. Thus, on passing through the critical range, the metal undergoes certain constitutional changes and at the end of it, is born a new grain structure—the Austenitic grain structure.

Different steels possess different initial Austenitic structures. This Austenite grain structure develops or coarsens gradually as the metal is heated above the "Critical Range". No two steels will exhibit the same Austenitic grain coarsening characteristics above the "Critical temperature range". Some steels will show more Austenitic grain coarsening, and some less. This Austenitic grain-coarsening characteristics is, what is termed as "Grain-size" control in its latest metallurgical sense. It depends upon the chemical composition of the steel and certain rather exacting features of steel making, notably the mode of deoxidation and the final residual deoxidant in solution in the cast steel. Besides other elements Aluminium is a strong deoxidant. Strong deoxidation of the steel with Aluminium tends to raise the temperature at which austenite grain growth takes place on heating above the "Critical Range". In a steel to which a small amount or no Aluminium has been added, austenite grain growth takes place readily at a temperature not far above the critical range and progresses rapidly as the temperature rises. The former is termed an "Inherent Fine Grain" or simply "Fine Grain" steel and the latter as an "Inherent coarse grain" or simply "Coarse Grain" steel. These new and specific meaning of the grain

size terminology should be clearly borne in mind since this inherent or Austenitic grain size may not necessarily have any relationship with the grain size of the steel as it goes into service. The room-temperature grain size of a steel is influenced mostly by the conditions of casting and the subsequent thermal and mechanical work to which the steel is subjected; whilst the inherent or Austenitic grain size is influenced by the deoxidation practice of the steel making and particularly by the residual Aluminium in solution in the steel. There may be two steels, one showing a fine room temperature grain structure and the other coarse. Yet, it is possible that the latter if it contains suitable additions of Aluminium would resist grain coarsening above the critical range and would thus be an " Inherent fine grain " steel in relation to the former which, if it were not suitably deoxidized or what is termed as " Killed " with Aluminium, would show great propensity to grain growth at relatively low temperature above the critical range and would thus be an " Inherent coarse grain steel ". On the other hand, if there are two types of steel, one fine Austenitic grained and the other coarse Austenitic grained size, both identically worked and subjected to identical heat treatments or say normalised (i.e. air cooled from just above the critical temperature range), then their normalized grain structures will likewise tend to be fine and coarse in the case of the former and the latter respectively. The normalized grain structure in the two cases, will not however, reveal the actual Austenitic grain size prevailing above the critical temperature range. To reveal this actual Austenitic grain size, various methods have to be employed and will be referred to later. The composite Micro-photograph Fig. 2 illustrates the difference in grain-coarsening characteristics between coarse and fine grained steels. The two steels had been heated up to progressively higher temperatures and air cooled. Their structures were then examined. The coarse Austenitic grained steel started to coarsen at about 1450°F., whereas the fine grained type exhibited the same fineness of structure upto 1900°F.

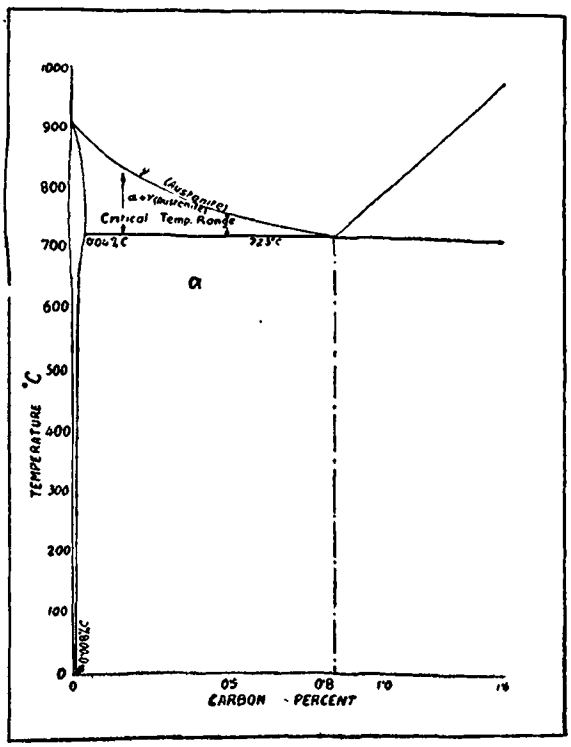


FIG. 3. Diagram showing the critical temperature range for Plain Carbon Steels.

Fig. 3 shows a diagramatical sketch showing the critical temperature range for plain carbon steels.

It has been shown that in a properly deoxidized plain carbon steel a final residual content of 0·03 to 0·04 % of Aluminium in solution confers upon it an " Inherent fine Austenitic grain " structure. Most of the Engineering, steels examined by this Inspectorate have shown upto a maximum of 0·003 % Aluminium in solution.

The earlier notions that aluminium addition to steels result in detrimental non-metallic inclusions have now lost ground. It is apparent that the objection to Aluminium additions arose from the fact that these had been employed as dope in the past to condition over-oxidized and badly worked heats of steels and under these conditions gave rise to large aluminium inclusions. If, however, the heat is properly worked and deoxidized, the aluminium additions are very useful in imparting an " Inherent fine grain " quality to the steel.

Differences between Coarse and Fine Austenitic Grained Steel.

To an Engineer's mind, the question will naturally occur that if the new conception of " grain size " refers to its grain-coarsening characteristics at high temperatures above the " critical range ", what relation has it with the physical properties of the metal with which he is mainly concerned to determine its suitability for a particular purpose. The answer is simple. The high temperature grain-growth characteristics greatly influence the physical properties and the response of the metal to various heat-treatments particularly that of hardening. Besides, the resistance to grain growth at high temperatures above the critical range renders unnecessary certain heat-treatment cycles following case-carburization. The inherently fine grain steels possess certain marked favourable physical properties compared to the inherently coarse grained type, the most outstanding of which is their high impact toughness. As will be shown later, the fine Austenitic grained steel eliminates the necessity of its being alloyed with some expensive elements to develop certain physical properties. Furthermore, low alloy inherent fine grained steels can economically replace highly alloyed costly steels.

The knowledge of Austenitic grain size is of little value unless its effect upon the physical properties of steel are known and applied in service. The following summarizes the influence of grain size variations on the physical properties and characteristics of steel.

I. Impact and Tensile Properties.

From the results of numerous investigations it is now well established that the fine grained steels possess much higher impact values than coarse-grained types of identical chemical composition and tensile properties. In normalized condition the fine grained steels have a slightly lower ultimate tensile strength, a higher elongation and a substantially higher notched-bar toughness. This is illustrated in 0·40% Carbon steels as below :—

Grain size.	Tensile strength tons per sq. inch.	Elongation %	Izod Impact.
Coarse ..	44	22	15 ft. lbs.
Fine ..	40	28	55 ft. lbs.

When inherently fine and coarse-grained specimens of the same steel are quenched from above the critical temperature range and tempered under the

same conditions, the former have a slightly lower tensile strength, a slightly higher elongation and reduction in area and a substantially higher notched-bar toughness. Carpenter gives the following results in the case of a 0·5 % carbon steel oil quenched from 840° C. in the form of 1·1/8″ diameter bar and tempered at 650° C. :—

Grain size.	Tensile strength tons/sq. inch.	Yield stress tons/sq. inch	Elongation	Red of A %	Izod impact ft. lbs.
Coarse ..	53·1	37·0	25·5	59·2	16·7
Fine ..	50·0	35·1	27·0	61·6	76·0

The impact toughness of the fine grained steel was distinctly superior. When this fine grained steel after quenching was tempered at 600° C, it gave the following values :—

Tensile strength tons per sq. inch.	Yield stress tons/sq. inch.	Elongation %	Red of A %	Izod Impact ft. lbs.
53·4	..	26	57·2	54·7

The tensile strength was the same as that of coarse grained steel but Izod value was much higher. Scott has shown that when the coarse and fine grained types of the same steel are heat-treated to give the same hardness values say between 400 and 600 V.P.H. No., the toughness of the fine-grained type is much greater than that of the coarse-grained.

Grain size.	Hardness value.	Izod impact value ft. lbs.
Fine	440	37
Coarse	440	8
Fine	600	25
Coarse	600	6

Daven-port and Bain took one steel, heated to different temperatures above the critical temperature range to develop different Austenitic grain sizes and quenched from a uniform temperature and tempered at different temperatures to give a Rockwell hardness of C 50. The results are given below :—

Heating temperature.	Quenching temperature.	Austenitic grain size develop at the heating temperature.	Hardness C Rockwell.	Impact ft. lbs.
760°C	760°C	Very fine	50	11
845°C	,,	Fine	50	3
930°C	,,	Coarse	50	2
1010°C	,,	Very coarse	50	1

The results show that the Austenite grain size established during heating greatly influences the toughness of the heat-treated steel. The author obtained the following values in the case of 0·20 % carbon steels one treated with Aluminium and the other Aluminium-free both in the normalized state :—

Izod Impact Average.

Fine grain	82·4 ft. lbs.
Coarse grain	37·6 ft. lbs.

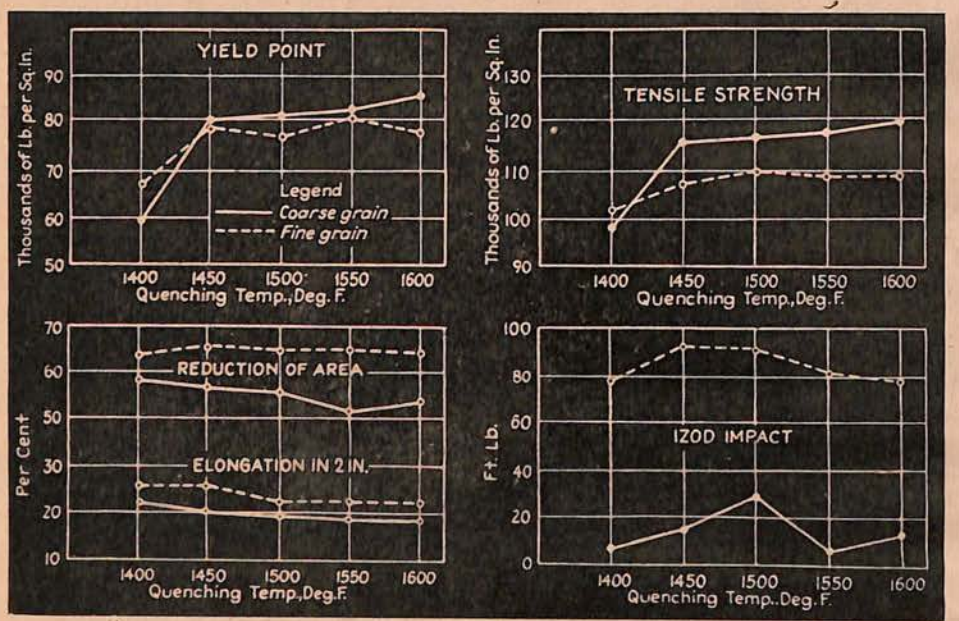


FIG. 4.—Graphs illustrating the differences in the Physical Properties of a Coarse and a Fine Grained S. A. E. 1040 Steel Quenched from the Temperatures Indicated and Tempered at 1050 deg. F. (Courtesy of P. Schane, Jr.)

O'Neill gave the following results for straight carbon steels in coarse and fine grain condition.

	A	B
Carbon ..	0·35%	0·35%
Silicon ..	0·22%	0·25%
Manganese ..	0·95%	0·96%
Sulphur ..	0·027%	0·027%
Phosphorus ..	0·036%	0·036%
Nickel ..	0·44%	0·46%
Chromium ..	0·06%	0·09%
Aluminium ..	0·001%	0·009%

Grain	Coarse	Finer
Yield stress tons per sq. inch	29·4	30·4
Max. stress tons per sq. inch	44·6	43·4
Elongation %	64	66
Izod value ft. lbs.	12	93

Fig. 4 shows a chart illustrating the relative physical properties of coarse and fine grained steels after quenching from various temperatures followed by tempering at 1050° F.

Hardenability (Hardness & Penetration).

The properties of quenched steels are more directly related to their Austenitic grain size than those of annealed or normalized steels. It is necessary to differentiate between the potential maximum hardness attainable and hardenability or the depth of hardening of the mass of the metal. The maximum surface hardness attained on quenching does not greatly depend upon the Austenitic grain size for a given mass but the depth of hardening is influenced by the Austenitic grain size to a marked degree. This is illustrated in the following three diagrams, 5, 6 & 7.

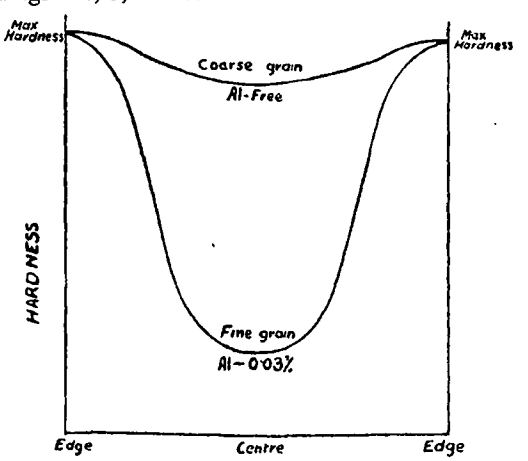


Fig. 5. Curves illustrating the variation of Hardenability with Grain Size.

The upper curve represents a deep hardening coarse grained steel and the lower curve a fine grained shallow hardening steel in which the hardness drops to a very low value in the Core. The surface hardness is the same in both the cases. Both the steel were quenched from the same temperature.

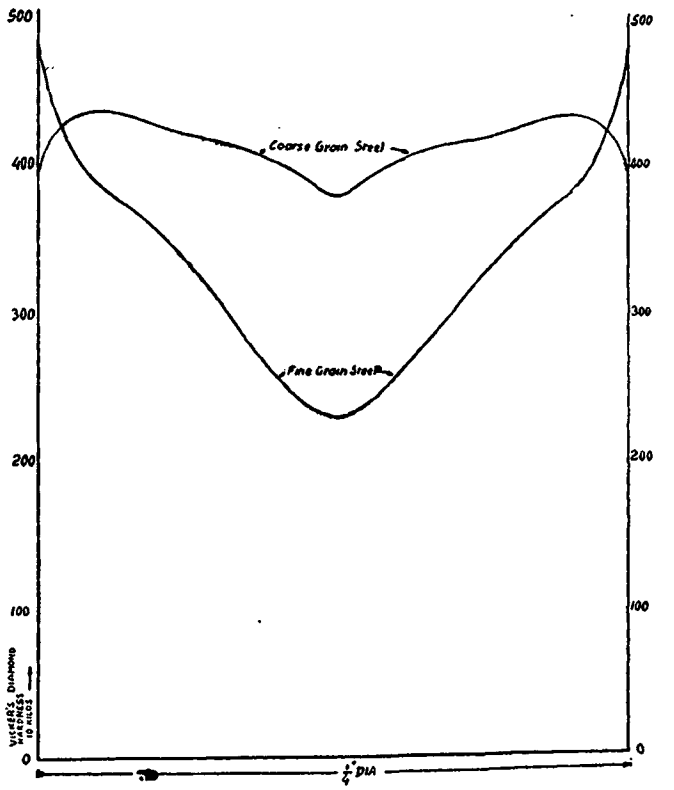


FIG. 6. Curves illustrating variation in Hardenability with Grain Size.

The curves shown above represents results obtained by the Author on two low carbon steels of identical composition, one of fine Austenitic grain size and the other coarse. The fine grained steel contained 0·02 % Aluminium while the coarse grained was Aluminium free. Both steels were quenched from 980° C. (Nijhawan).

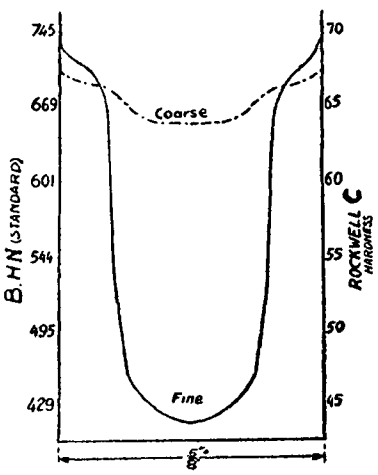


FIG. 7. Hardness Distribution across the $\frac{5}{8}$ inch thickness of two specimens of the same bar of Tool Steel.

One heated to 990° C., the other to 815° C., both quenched from a fixed temperature (Daven-port and Bain).

Daven-port and Bain heated two specimens of the same steel at 990°C. and 815°C. respectively. In the former a very coarse grain size was established and in the latter a fine grain size. Both specimens were cooled to 745°C. and quenched and the hardness at a series of fixed points determined across the section. Fig. No. 7 gives the hardness values across the section :

In general, the fine grained steels are shallow-hardening and the coarse grained types are deep-hardening and less subject to mass effect.

Due to larger Austenitic grain boundary surface areas in the case of fine grained steels, the transformation rates of these steels on quenching are faster than the coarse grained types. So in the case of the former the core undergoes comparatively rapid transformation and liberates more of the ferrite which makes it less hard and renders the steel shallow-hardening.

Since the toughness or impact values of hardened steels increase as the hardness diminishes, fine austenitic grained steels are not so hard in the core as coarse Austenitic grained steels. Therefore, they have tougher cores and resist dynamic stresses to a greater extent than similar deep hardening coarse Austenitic grained steels. Fine grained plain carbon steels can be economically substituted for low alloy steels where high core toughness is important. However, in tool and certain other types of steels where deep hardening properties are essential, the fine grained steel is unsuitable. Alloying elements like Manganese etc. add to the deep-hardening properties of the steel.

Fine grained steels are less liable to macroscopic cracking during quenching. Cases are on record where by making the steel inherently fine grained through suitable deoxidation, the rejections due to cracking in the heat-treatment were entirely eliminated. Fine-grained steels are also less liable to warping and distoration during heat-treatment. It has been further established that the micro-cracks observed in quenched steels result from large dimensional changes that increase with increasing grain size. Thus, the superior toughness of fine-grained steels is due to some extent at least, to the existence of a smaller number of microscopic cracks. Coarser grained steels have higher internal stress after quenching and are therefore, more susceptible to grinding cracks than the finer grained types.

However, due to their more rapid rates of transformation, finer grained steels are more prone to soft spots on quenching and are not suitable where full uniform hardening throughout the section is desired.

Machinability and Surface Finish and Forgeability and Pressing.

In America the view is widely held that coarse-grained steels machine better than fine grained. It is stated that in the coarse grained steels the size of the final ferrite and carbide lamellae resulting from the transformation of Austenite, is coarser and hence better machinability is imparted. However, completely identical results have not been obtained elsewhere. Where there is a great difference in the machinability as in the case of free-cutting and ordinary steels, it is easily shown but when the difference is small, it is difficult to discover which of the two types possess superior machining properties. However, the coarse grained structure causes roughness of the finished surface and the fine grained steels give a superior finish. In punch press operations fine grained steels exhibit several advantages over the coarse grained types. It has been shown that finished surface of fine grained mild sheets steels were much superior to those of coarse grained steels since the latter became rough after deep drawing whereas the fine grained steel remained smooth and uniform. In blanking,

fine grained types shear cleaner and exhibit smaller burrs and are less embrittled by cold work and therefore may be drawn deeper and show fewer defects than the coarse grained steels. Fine grained steels are more suitable for heavy punching operations, drastic cold rolling, shearing and trimming.

It is also reported that coarse grained steels forge more readily than fine grained types due to low interference to slip in the coarse grained types and that coarse-grained types give better fibre structures than the fine grained steels on forging.

Carburizing Characteristics.

It has been observed that the rate of diffusion of carbon into fine grained Austenite is less rapid than in the coarse grained Austenite and so fine grained types carburize less deeply and more slowly than the coarse grained steels. Fine grained steel are prone to give abnormal or soft spots on quenching after carburization. 'Abnormal' spots refer to a coalesced state of carbide which causes low hardness values. The object of carburization is to obtain components with a case possessing a high surface hardness and of sufficient depth and a soft but tough core. The carbon content of a low carbon steel is usually raised by heating for a sufficient length of time in a carburizing atmosphere i.e., usually in a container packed with a solid carburizing compound. The carburized material is then quenched to harden the case. Apart from the shallow-hardening characteristics of fine grained steels these are ideal for carburizing. During the prolonged heating at the carburizing temperature, pronounced grain growth occurs in steels which have not been suitably deoxidized and are therefore coarse-grained. So after case-carburization, grain-refining treatments have to be carried out. The following is a complete cycle :—

(a) Carburization and air cooling of the box after carburization.

(b) Heating the material to just above the critical temperature range of the core, about 850°C-880°C. to refine its grain size, followed by quenching in oil or water.

(c) Heating just above the critical temperature range of the high carbon case, about 750-770°C. to refine its grain size, followed by quenching in oil or water.

(d) Final tempering at about 200°C. to relieve the internal stresses.

Where fine-grained steels are employed, the core and case retain their fine-grained characteristics after prolonged heating at the carburizing temperature and hence the core and case grain-refining operations etc. can be safely omitted and the case-carburized material quenched directly from the carburizing box. In some cases even the final tempering may also be dispensed with. It is now realized that so long as an allowance is made for the slower penetration of carbon in fine grained steels, these have pronounced advantages over the coarse-grained types in materially cutting down heat-treatment costs and time, yielding more production of an equally good if not, better case-hardened material. There is always the danger of warpage, distortion, macro-cracks in the heat-treatment cycle following carburization of the coarse-grained steels e.g., in case-hardened gear applications. Such dangers practically do not exist in fine-grained steels.

"*Pipe*"—*Shrinkage cavity* :—It is claimed that fine grained steels tend to give a deeper pipe than normal coarse-grained steels.

Decarburization :—It is reported by some investigators that coarse grained steels show a greater tendency towards de-carburization than the fine-grained types.

Aging :—It has been reported that fine-grained steels age much less than coarse-grained steels. The coarse grained steels show after aging an increase in the hardness, tensile strength, yield point and a greater loss in the impact toughness, reduction of area and elongation values than the fine-grained steels. In one case, the impact toughness of a fine-grained steel was actually shown to increase after aging. Embrittlement failures in boiler plate due to aging of strained areas abour rivet holes, have been eliminated by the use of fine grained non-aging Izett steel.

Temper-Brittleness :—Temper-brittleness is the name applied to the loss of ductility or impact toughness that results after tempering hardened specimens to a temperature below the critical range followed by slow cooling. Steels containing alloying elements like nickel, chromium are chiefly susceptible to temper-brittleness. It has been shown by various workers that after tempering in the temper-brittleness range the Izôd impact values of the fine grained steels are much greater than coarse-grained steels although the latter is somewhat less susceptible to temper-brittleness than the fine grain aggregates.

Magnetic Properties :—Ruder has correlated the existing data of the effect of grain size upon the magnetic properties of steels and has shown that the hysteresis, coercive force and residual all decrease with increase in grain size. This condition varies with prior treatments whether mechanical or chemical and consequently the effect of grain size cannot readily be ascertained.

Grain size control and its practical applications:— A full understanding of the characteristics of fine and coarse grained steels has led to the choice of each type for different purposes. Coarse grained steels are recommended for easy machinability, deep hardening etc. and fine-grained steels are preferred for advantages hitherto obtained from alloying elements e.g., greater toughness with a given strength and hardness, wide heat-treating range, freedom from danger of cracking, warpage etc., and the elimination of grain-refining treatments after carburizing. All these attributes should be taken into consideration for the purpose of selection of the steel for a particular purpose. Where machinability is of prime importance, fine-grained steels with their attendant higher toughness etc., can also be usefully employed after normalizing from a high temperature to improve their machining. Where deep hardening properties are of paramount importance, fine-grained steels could also be employed with an increased manganese content and their slightly lower strength improved by tempering at a lower temperature. A balanced view of the whole range of the characteristics of the two types has established that for all uses of steels involving heat-treatment, fine grained materials with suitable alterations of heat-treatment and composition, are of a actually better quality than coarse grained types. Fine-grained steels can be economically substituted for low alloy coarse grained types and fine grained low alloy steels substituted for high alloy coarse grained types. For example, in case-carburized or hardened gear applications, low alloy coarse grained steels can be replaced by fine grain un-alloyed steels which, because of their shallow hardening characteristics give an equally hard case and a tougher core with complete freedom from dangers of distortion and cracking during hardening following carburization or hardening as such. This control of distortion is important in order to avoid heavy localized tooth pressure by irregular and small tooth contacts. Besides, the grain-refining operations following carburization can be safely omitted with attendant economy and an increased production of a sounder, crack-free, case-hardened product. In particular cases, even carburization itself may be eliminated since fine-grained shallow hardening steels on hardening will give an outer shell of fully hardened steel produced on a softer but tougher core of the same composition.

Swinden and Bolsover state that they are in favour of inserting a grain size specification clause for engineering materials which will ensure a more regulated product and will serve as an alternative, within limits to the addition of increased contents of alloying elements which may be comparatively expensive and which almost certainly add to the difficulties of manipulation and heat-treatment of the alloyed materials as well as, in some cases, causing complications connected with such operation as flame-cutting and welding. Flame-cutting and welding of coarse-grained alloy or carbon steel cause excessive and deep hardening of the metal with possibility of cracking therein. Without making exaggerated claims for the fine grained steels it can be stated that if and when the Engineer desires better impact toughness with a given tensile strength or a high tensile strength with a given impact resistance it will be worthwhile for him to study the possibility of achieving his objective by the use of controlled-grain size steel as a substitute for a low or highly alloyed steels.

Hugh O'Neill in his excellent paper on " Alloy and Fine grained steels for locomotive complying rods " (J.I.S.I. 1937 No. 1) gives details of plain carbon steels of inherent fine grain which yield practically the same mechanical properties as low alloy steels and are giving satisfactory performance both during manufacture and in service as coupling rods for the L.M.S. Railway.

William (J.I.S.I. 1938 II) while referring to American steel industry estimated that 75 % of all killed steel made in the United States is made under specifications requiring grain size control. In general, it is now possible to produce steels of coarse or fine grain at will, by the omission or regulated additions of aluminium to steel of just the proper degree of deoxidation. Intermediate sizes cannot be so precisely controlled yet but progress is being made through the use of vanadium, titanium and zirconium separately and in various combination along with aluminium.

With India on the threshold of big post-war industrial development in the field of Metallurgy, it will be a wise and far-sighted attitude on the part of Indian steel-makers as well as the users like the Railways, to study the application of grain size control to their requirements of various types of Indian steels which have hitherto been made or will have to be produced in the not too distant a future in this country and which will in the long run feed the heavy Indian Engineering Industries such as the manufacture of locomotives automobiles and the rest.

Methods of Determining Austenitic Grain Size

A. McQuaid-Ehn Carburizing Test.

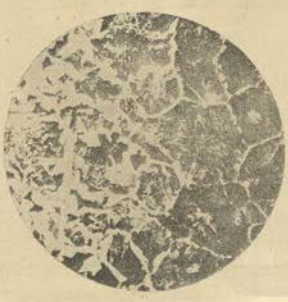
This is based on the work of original American investigators and issued as the A.S.T.M. Standard E. 19-33.

A specimen is selected of a suitable size to obtain a convenient Microsection when parted into two. All scale is removed from the specimen and it is packed in a box containing a good carburizing compound. The box is carefully sealed to prevent the escape of carburizing gases. The box and contents are heated in 2 hours and soaked for 6 hours at 927°C. and then allowed to cool slowly down to 400°C. before emptying. A section is cut from the sample, polished on the cut face and etched. The free carbide of the carburized case outlines a clearly defined grain size which is examined on a projection microscope at a mignification of 100 diameters. Comparison of the projected fields with those given on the standard charts in Fig. 8 which shows typical standard fields for each grain size, enables the inherent Austenitic grain size of the specimens

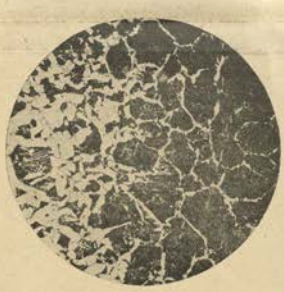
FIG. 8—GRAIN SIZE CHART FOR CLASSIFICATION OF STEELS (A.S.T.M. STANDARDS)
Samples carburized at 1700°F. (927°C.) for 8 hours (X 100)

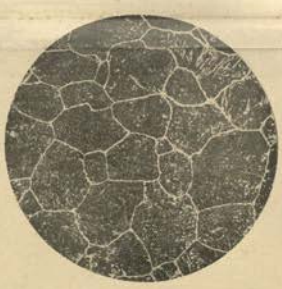
Hypo-Eutectoid

Hypereutectoid

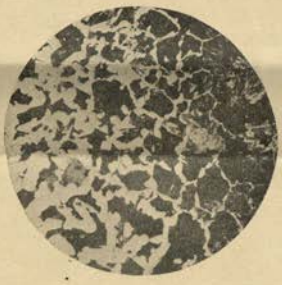


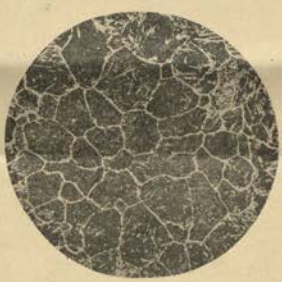
No. 1. Up to 1·1/2 grains per sq. inch.



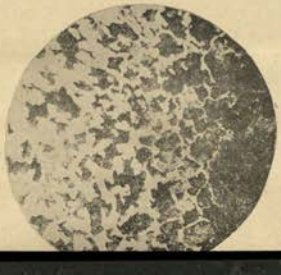


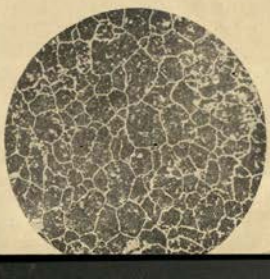
No. 2. 1·1/2 to 3 grains per sq. inch.



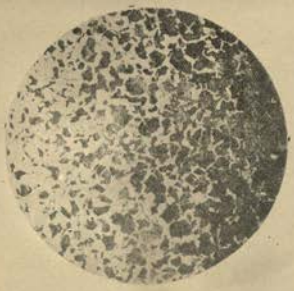
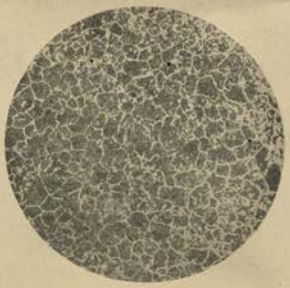


No. 3. 3 to 6 grains per sq. inch.

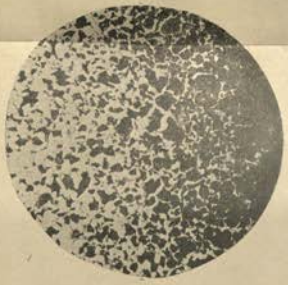
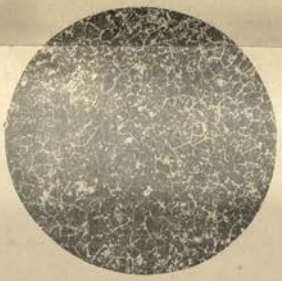




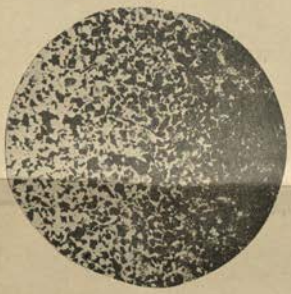
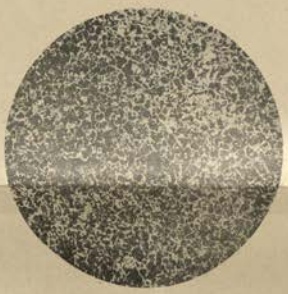
No. 4. 6 to 12 grains per sq. inch.

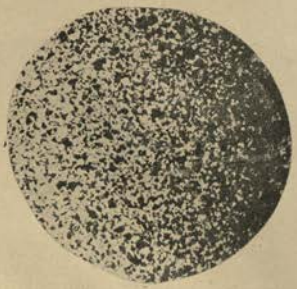
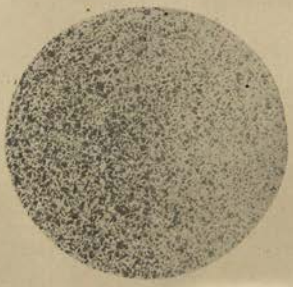
No. 5. 12 to 24 grains per sq. inch.

No. 6. 24 to 48 grains per sq. inch.

No. 7. 48 to 96 grains per sq. inch.

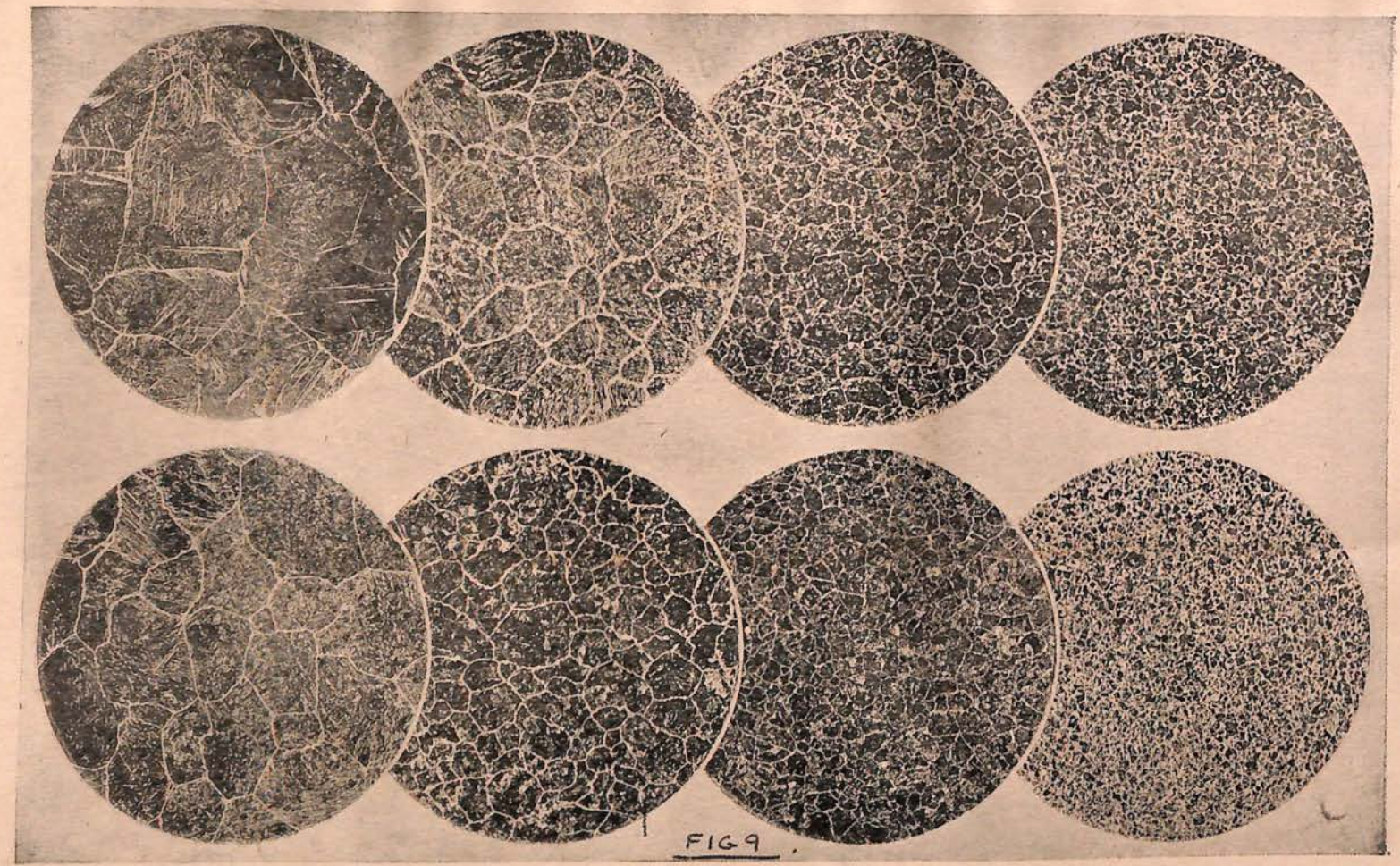



No. 8. 96 grains and more per sq. inch.

FIG. 9.—STANDARD GRAIN SIZES FOR STEELS.

Carburized and slowly cooled to develop cementite network. Magnified 100 diameters. Micros courtesy Timken Roller Bearing Co.

Grain Size No. 1. Up to 1½ per sq. in. No. 3. 3 to 6 grains per sq. in. No. 5. 12 to 24 grains per sq. in. No. 7. 48 to 96 grains per sq. in.



No. 2. 1½ to 3 grains per sq. in. No. 4. 6 to 12 grains per sq. in. No. 6. 24 to 48 grains per sq. in. No. 8. More than 96 grains per sq. in.

to be assessed. It is an arbitrary method of determining the size of the Austenite grains which had formed at a specified carburizing temperature, i.e., 927°C. The grain size is reported as a number which, in fact, represents the numbers of grain per sq. inch at a magnification of 100 diameter. The following tabulation illustrates the basis of the 8 Standard grain sizes normally worked to—

Grain size index. N	Number of grains per sq. inch × 100, n		
	Mean	Maximum	Minimum
1 ..	1	1·5	..
2 ..	2	3	1·5
3 ..	4	6	3
4	8	12	6
5 ..	16	24	12
6 ..	32	48	24
7 ..	64	96	48
8 ..	128	..	96

As the basis of this table is $n = 2^{N-1}$, the index for smaller or larger grain size may be calculated. Most coarse grained carbon steels have the index 2 or 3 and most fine grained have 6 or 7. In alloy steels, the grain sizes are smaller and when the content of alloying elements is substantial, the effect of strong deoxidation etc., on the grain size and its accompanying characteristics tends to become negligible. The Mcquaid-Ehn test has become the standard method of determining Austenitic grain size and is one of the major routine tests employed by user and producers in America. All the characteristics of the fine grained steels can be related to the Mcquaid-Ehn-grain size.

Fig. 9 shows the standard Austenitic grain size chart for steels prepared by Messrs. Timken Roller Bearing Co. of America.

There are some other methods of ascertaining the Austenitic grain size and are outlined as follows:—

Oxidation method:—Suitable marking of the Austenitic grain boundaries can be obtained by heating a polished surface of a specimen in an electric furnace at a standard temperature. The specimen is then taken out and air cooled. The oxide scale is removed and the specimen repolished and etched. The former Austenite grains are outlined by the absorption of oxygen at the Austenitic grain boundaries.

Another method developed by O'Neill flash-etches the Austenitic grain boundaries at the surface of steel specimens at high temperature by dry chlorine. The specimen is then cooled, suitably etched and examined.

In carbon steels of about 0·7-0·9% carbon content, the steel is simply quenched from above the critical temperature range and the former Austenite grain size revealed by etching with " Villella & Bain " etching reagent preferably after tempering the specimen at 200° C-300° C.

In low and medium carbon steels a simple method is to take a steel test-piece, heat to above the critical temperature range, water-quench one of its end whilst leaving the other end to air cool. The test piece is then longitudinally cross-sectioned and micro-examined. The former Austenitic grains are in one area in the section outlined by a dark, partially transformed product of Austenite, termed Troostite, around Martensitic matrix—another transition product obtained during the transformation of Austenite.

The Shepherd-Penetration-Fracture Test for Tool Steels.

The Shepherd-penetration-fracture or simply P-F test consists essentially in subjecting four samples of tool steels in question to brine quench at temperatures of 1450°F., 1500°F., 1550°F. and 1600°F. respectively. Each specimen is then notched and broken, and from a comparison of one of the fractures with a set of standard fractures, the fracture-grain-size is determined. The penetration is determined by macro-etching the other half. From a correlation of these data, the P-F values are determined.

Results :—The Metallurgical Laboratory of this Inspectorate has been conducting from time to time Mcquaid-Ehn carburizing Austenitic grain-size tests in the course of its investigations on various types of steels including failed Railway materials, both of Indian and non-Indian manufacture. It is not possible to give here all the results of such grain-size determinations. However, micro-photographs Nos. 10 to 21 illustrate the Mcquaid-Ehn Austenitic grain sizes revealed in the course of such investigations. The necessary details are given.

It is a policy of this Inspectorate to pursue further investigations on "Controlled Grain Size" particularly on Indian steels in their application to Engineering and Railway materials and other allied steel industries.

Comments on the results :—Tyre steels represented by Figures 13, 14 and 15 of fine grained quality gave Izod values of 11 ft. lbs. against the values of 4 ft. lbs. given by the coarse grained tyre steels shown in Figures 10, 11 and 12. The former contained Carbon 0·58%, Manganese 0·62%, Sulphur and Phosphorus each below 0·04% and the latter contained Carbon 0·59%, Manganese 0·58%, Sulphur and Phosphorus each below 0·04% i.e. both possessed identical composition.

Duplexed Austenitic grain structures have also been observed by Lauderdale and Harder on case-carburized S.A.E. steels and is believed to be due to excessive rate of growth of some individual grains following certain conditions of deoxidation of the steel.

Acknowledgements.

No claim for originality is intended in this short review. It is merely an outline of the data on the subject to which are appended just the minimum of the experimental results obtained here, designed to introduce the subject to the Engineers.

The author desires to acknowledge gratefully the invaluable advice and encouragement which he has received from Mr. R. C. Arbery, O.B.E., Controller of Inspection (Metallurgical), Department of Industries and Supplies. The author also wishes to thank Mr. T. V. N. Kidao, Assistant Inspecting Officer, Department of Industries and Supplies for assistance.

PHOTO MICROGRAPHS SHOWING AUSTENITIC GRAIN SIZE IN STEELS.

FIG. 10. Coarse grained tyre steel etched in Sodium Picrate.
X 100

FIG. 11. Extremely coarse grained tyre steel etched in Nital.
X 100

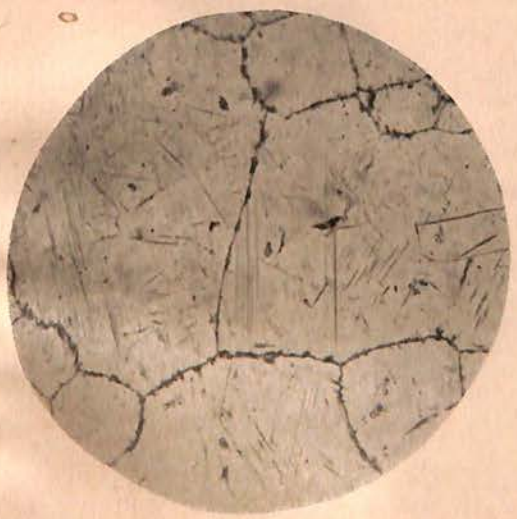


FIG. 12. Coarse grained tyre steel etched in Sodium Picrate.
X 100.

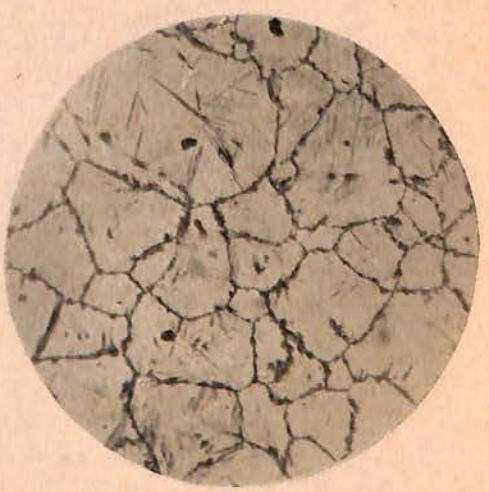


FIG. 13. Fine grained tyre steel etched in Sodium Picrate.
X 100

PHOTO MICROGRAPHS SHOWING AUSTENITIC GRAIN SIZE IN STEELS.

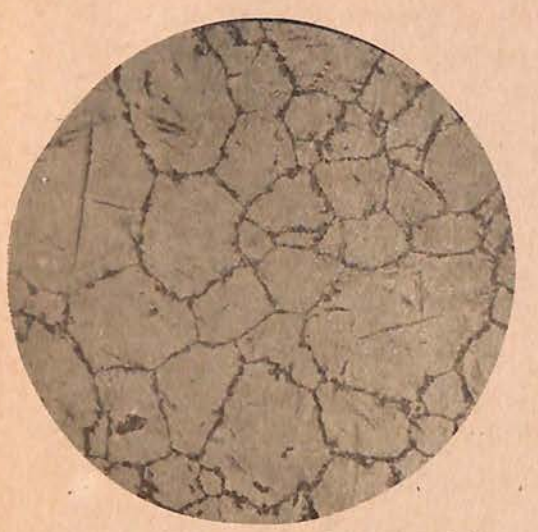


FIG. 14. Fine grained tyre steel etched in Sodium Picrate.
X 100

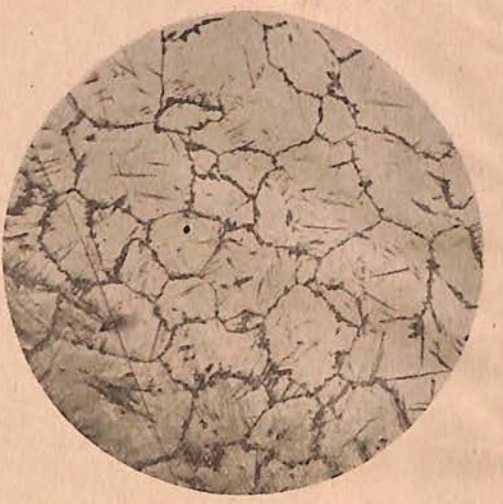


FIG. 15. Fine grained tyre steel etched in Sodium Picrate.
X 100

FIG. 16. Fine grained tyre steel etched in Nital.
X 100

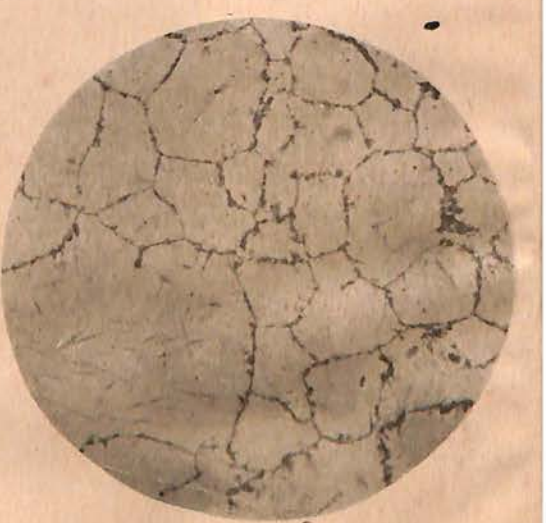


FIG. 17. Duplexed grained tyre steel etched in Sodium Picrate.
X 100

PHOTO MICROGRAPHS SHOWING AUSTENITIC GRAIN SIZE IN STEELS.

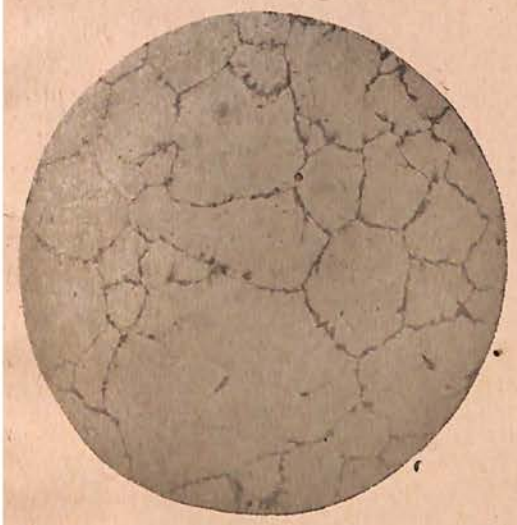


FIG. 18. Tyre steel showing Duplexed grained structure etched in Sodium Picrate.

X 100

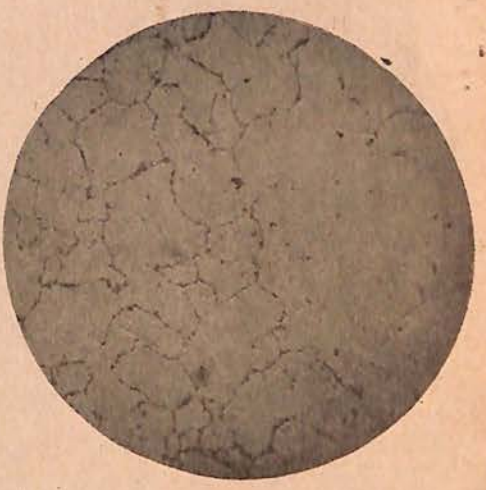


FIG. 19. Axle steel showing Duplexed grained structure etched in Sodium Picrate.

X 100

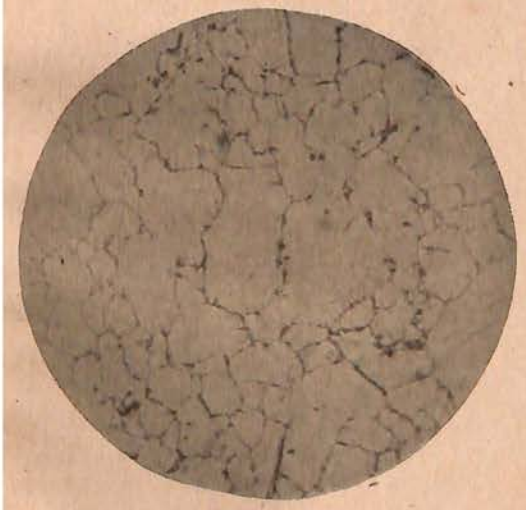


FIG. 20. Fine grained Axle steel etched in Sodium Picrate.

X 100

FIG. 21. Coarse grained Axle steel etched in Sodium Picrate.

X 100

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POST-WAR PLANS

PARTS 3—7.

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4. AERODROME AND AIR ROUTE ORGANISATION.
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6. AERONAUTICAL TRAINING AND EDUCATION.
7. RESUME OF CIVIL AVIATION PLANS, HEADQUARTERS ORGANISATION AND ESTIMATED REVENUE.

PUBLISHED BY THE MANAGER OF PUBLICATIONS, DELHI
PRINTED AT THE CIVIL & MILITARY GAZETTE LTD.
48, THE MALL, LAHORE.

Price 4*s*. 14 *or* 1*s*. 3*d*.

CIVIL AVIATION POST-WAR PLANS PARTS—3—7

FOREWORD

The two major parts of the Post-War Plans for the development of Civil Aviation have already been published and are obtainable, price 14 annas, from the Manager of Publications, Delhi, namely—

PART 1.—POST-WAR AIR TRANSPORT PLAN

PART 2.—POST-WAR PROGRAMME OF CIVIL AVIATION CAPITAL WORKS (Aerodrome and Air Route Construction).

The Plans printed in the present publication are substantially in the form in which they were submitted to the Policy Committee No. 3. B—Posts and Aviation, at its second meeting held on 8th January 1946. These Plans will be modified in accordance with suggestions received during their examination. The text has been abbreviated and otherwise modified in a few respects.

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Speech delivered by the Hon'ble Sir Mahomed Usman, K.C.S.I., K.C.I.E., Member in charge of the Posts and Air Department at the Second Meeting of the Reconstruction Policy Committee, 3-B—Posts and Aviation, on the 8th January, 1946 :

Gentlemen,

I have great pleasure in welcoming you to this second meeting of the Reconstruction Policy Committee dealing with Posts and Aviation. I had the pleasure of meeting you and addresing you at the first meeting of this Committee on the 21st April 1944 when we presented to you certain plans for the development of civil aviation in India. They dealt with Internal Air Transport, Aerodrome and Air Route Construction and Aerodrome and Air Route Organisation. Further plans have now been prepared in respect of the remaining aspects of civil aviation development and, now, are for your consideration and advice. We have also presented to you the post-war plan of the Indian Posts and Telegraphs Department. About this plan, I shall have a few observations to offer, when you have completed the consideration of the civil aviation plans. For the present, I shall confine my remarks to the civil aviation plans.

2. I regret that the interval which has elapsed since this Committee last met, has been longer than we expected but in the meantime, there have been important developments requiring the attendance of officers of the department at Conferences abroad and other developments consequent on the ending of the war with Germany and Japan. This unfortunately made it impracticable to complete the plans and call you together earlier.

3. The civil aviation plans placed before you today include three of outstanding public importance, namely the plans relating to External Air Services, Aeronautical Training and Education and the Aeronautical Radio Service. The remainder deal with sundry aspects of the organisation required to give effect to the development proposed, but among these, the plan for the organisation of the Civil Aviation Directorate which will be responsible for the direction and execution of the whole plan, is of considerable importance.

4. At the first meeting of the Committee, I gave you an outline of the problems concerning international air transport which then awaited discussion and it will be appropriate for me now to tell you something of what has happened since then. In July 1944, the Government of India accepted an invitation to send representatives to Washington to discuss with the United States Government the problems of international regulation of aviation and, in particular, air transport, as a preliminary to the calling of an international conference. The International Civil Aviation Conference was convened by the United States Government and met in Chicago in November and December 1944. As a result, a new international convention "The Convention on International Civil Aviation" was drawn up and signed by practically all of the 52 nations represented at the Conference. The Convention may be regarded as a modernised version of the International Convention for the Regulation of Air Navigation signed in Paris in 1919 and it covers the same field. As you are aware, there were prolonged discussions on the subject of the regulation of international air transport, but on this subject, the Conference failed to reach agreement. The Convention, which is subject to ratification and which has not yet been ratified by India, does not, in consequence, give any general rights for the operation of scheduled air transport services, but covers the whole of the field of the regulation of international aviation generally and the establishment of uniform regulations, standards and procedures.

5. An Interim Agreement, providing for the establishment of a Provisional International Civil Aviation Organisation pending the ratification of the Convention was prepared and signed by practically all countries represented. India was

elected to one of the 21 seats on the Interim Council which has since held its first meeting in Montreal. India was represented at this first meeting and has now sent a standing representative to the Council, which is in continuous session dealing with the problems of international regulations and standards and with the outstanding problem of the regulation of air transport, which was left unsettled at Chicago.

6. As a result of the failure to agree on the subject of the regulation of international air transport, two other agreements were prepared at Chicago. The International Air Transport Agreement gives, as between the signatory parties, complete freedom to operate commercial air services between their territories. India has always supported the policy of regulation of international air transport and in consequence did not sign this agreement. A second agreement, called the International Air Services Transit Agreement, gives, as between the signatories, the right to operate scheduled air services in transit over each others territory and to land for non-traffic purposes. No commercial rights attach to this second agreement, to which the Government of India have adhered.

7. The present position therefore is, as before the war, that the operation of international air services to and across India can only be effected through the medium of a bilateral agreement with this country. Likewise for the operation of Indian air serivces abroad, it will be necessary to negotiate agreements with the other countries concerned.

8. In parallel with the international discussions, there has been a series of British Commonwealth Air Conferences, culminating in the establishment of a Commonwealth Air Transport Council, for the consideration of problems of mutual interest to the countries of the British Commonwealth. The Air Transport Council met in London in July 1945. One of the important conclusions from the Commonwealth discussions is the decision to abandon the earlier proposals to establish a Commonwealth Corporation for joint operation of international air transport within the Commonwealth. Each country will be responsible for the operation of its own international air services on such routes as it may consider of importance. Moreover, in accordance with the principles which were discussed and supported by India at the Chicago Conference, each Commonwealth country is recognised to have the right, *vis-a-vis* other members of the Commonwealth, to operate international air services in proportion to its traffic interest in the route. The External Air Transport Plan which is before you therefore provides, as an initial programme, in addition to regional air services, to the Near East, East Africa and China, and a service between India and the United Kingdom, to be operated on a standard comparable with the world air services which will be established by Great Britain, Australia and America. I need not emphasize that, of all the Commonwealth air routes, that between India and Great Britain is of transcending importance to India and until this operation has been accomplished, it is unnecessary to look further afield.

9. In view of the large programme of internal air transport development which must be our first care, it is not expected that India will be able, at an early date, to embark on an air service to Great Britain. There are compensating advantages in this, in that we shall start these operations with the most modern type of post-war aircraft; these are not yet available. In accordance with the agreements reached in the Commonwealth Air Transport Council, India, while operating her own independent air service, will share all the benefits of collaboration and the use of joint organisations established by the Commonwealth operators on this air route. In the meantime, we intend to establish, as soon as practicable, some of the regional air services from India, and thus will provide the necessary graduated experience of international operations both for operators and the operating personnel.

10. I would draw your attention particularly to the form of operating organisation which is proposed. Following the recommendation of the Policy Committee in regard to internal air transport at our last meeting, the operating organisation proposed is predominantly commercial. It is proposed to establish two companies or corporations—one for operation to the west of India and one for operation to the east of India. In each of these corporations, it is proposed to give a major but not a

majority interest to an established air transport operator in the internal air transport field, to provide an opportunity for investment by other air transport operators and the public and to reserve to Government a substantial, but not a majority, interest.

11. Reverting to the internal air transport plan which you considered at the last meeting, I may now remind you that Government have accepted the majority recommendation of the Committee, that the operation of these air services should be entrusted to private enterprise. Government, however, reserve the right to take a share in any air transport company to which a licence is granted, and themselves to operate any selected air service. In consequence we have proceeded with the preparation of the Air Transport Licensing Rules, the draft of which was published for information and comment in June 1944. The draft Rules have been modified in accordance with suggestions received, and the Government of India have engaged in a series of discussions with representatives of the Indian States in the hope that a uniform system of licensing of air transport may be established for the whole of India. I have every hope that this result will be achieved, and that the Licensing Rules will be promulgated in the course of the next month. It is proposed that the Rules, in so far as they relate to the granting of licences for air transport services, shall be brought into force with effect from the 1st October 1946.

12. In the interval since we last met, we have not been idle in the field of air transport. The two established operators—Tata Air Lines and Indian National Airways who, since 1942, have operated regular air services in support of the Air Force have gradually expanded their activities, with Government aircraft which have been issued to them. The withdrawal of Lease/Lend aircraft and the reduction of air services operated by the R. A. F. Transport Command has made it necessary to bring into service large aircraft of the DC-3 class., which these companies have recently purchased from the United States Foreign Liquidation Commission. At the same time, the opportunity was taken to place the air services operated by these companies on a commercial basis, while reserving to the priority control of Government, a proportion of the capacity operated thus supplying in part the urgent need of the public in India for air transport. From the first of January, daily air services with DC-3 class aircraft have been established on the routes Karachi-Bombay-Madras-Colombo, Bombay-Delhi, Calcutta-Dehli and Delhi-Karachi and a three times a week service on the route Delhi-Lahore-Peshawar. With the withdrawal of other R. A. F. services, it is hoped shortly to establish commercial air services on other routes. The measure of this assistance to the Government transportation problem, and incidentally to the public, may be gauged from the fact that in April 1944, Tata Air Lines and Indian National Airways operated air services giving an annual transport capacity of two million ton miles. The services now in operation provide an annual transport capacity of four million ton miles. During the year 1945, Tata Air Lines carried a total of 12,000 passengers and 400 tons of freight and mails; Indian National Airways carried 10,000 passengers and 250 tons of freight and mails. The air services operated for Government have been closely controlled and have provided an invaluable guide for the establishment of the post-war system. It is of interest to record that the cost of air transport foreshadowed in the post-war plans presented in April 1944, namely Rs. 1-9-0 per ton mile, has been almost precisely realised. On the revenue side, the growing demand for air transport both for Government purposes and to meet the needs of the public has shown that, after allowing for the disappearance of war travel, the traffic estimates will be very much improved and the cost to Government by way of subsidy correspondingly reduced. I need not add that the present development is of a provisional nature—a natural and necessary development of war time operations—and the whole of the air transport operations in India will come under review of the Air Transport Licensing Board when it is established.

13. I need only refer very briefly to the other plans which will demand your attention. The salient points have been brought out in the Memorandum which is before you, but I should not be putting matters in the right perspective if I did not draw particular attention to the importance of the proposals for Aeronautical Training and Education. These proposals embrace everything from general education in schools, through flying and gliding clubs, and a professional and trade

training school, to university education and post-graduate research. Some parts of this are deliberately sketched in outline only, and the extent of their development will be influenced and guided by the development of aviation itself. The most essential feature of the proposals is the Civil Air Service Training School, which will provide the means of training the aircrews, the engineers, the radio technicians and the flying control and other aerodrome staff, which are essential for the building up of aviation in India.

14. In the paper on the organisation of the Civil Aviation Directorate, you will find a summary of all the proposals. You will see that the capital expenditure is estimated at Rs. 18½ crores. This excludes the value of aerodromes and route organisation already established, and I need not emphasise that this is not the end. As regards the recurring expenditure if and when the plans are in full operation, this is estimated at Rs. 466 lakhs a year exclusive of interest and depreciation charges. This figure of Rs. 466 lakhs includes a provision of Rs. 280 lakhs for the subsidisation of air transport. This, however, is not a continuing commitment, and as I have already said, there is evidence that commercial revenue will produce a much larger proportion of the cost than that assumed in the plan. A rough estimate of the employment created in civil aviation is of the order of 10,000.

15. Finally, I would like to invite your attention to the proposal to establish an All-India Air Board. The desirability of co-ordination of the administration and development of aviation, which is of an essentially national character, in a country like India, needs no emphasis. While unification of administration is not constitutionally possible, it appears desirable to provide a forum for the discussion of matters of mutual interest to British India and the States. The Board can only be consultative and advisory in character. I invite your views on this matter.

16. My object has been to relate some of the important happenings and developments which have occurred since the last meeting and to give a pointer to the importance of the subjects before you. A short Memorandum dealing with each subject is before you. Before taking up to the individual items, members of the Committee may wish to make some general observations, or to have certain points elucidated. I shall be happy to give you such additional information as you may require.

Memorandum presented to the Reconstruction Policy Committee No. 3-B—Posts and Aviation, at their Second Meeting held on the 8th January, 1946.

At its first meeting held on the 21st April 1944, the Reconstruction Policy Committee 3B, Posts & Aviation considered the following plans for the development of Civil Aviation in India in the post-war period :—

(1) Plan for post-war civil air transport in India, briefly called the Internal Air Transport Plan.

(2) Aerodrome and Air Route Construction.

(3) Aerodrome and Air Route Organisation.

Since that meeting, as a result of consideration of criticisms and suggestions made by the Committee and others received subsequently, the Internal Air Transport Plan has been modified to a certain extent and a copy of the Supplement to the Plan is attached for information. The above plans have been accepted by the Government of India.

2. Further plans have now been prepared in respect of other aspects of civil aviation development and the following memoranda are for consideration by the Policy Committee at its 2nd meeting :—

(i) Plan for the operation by India of air services from India to countries abroad, briefly called the External Air Transport Plan.

(ii) Aeronautical Training and Education,

(iii) Aeronautical Radio Organisation,

(iv) Aeronautical Inspection Organisation,

(v) Civil Aviation Works Organisation,

(vi) Headquarters Organisation of the Civil Aviation Department.

Two other memoranda are submitted to the Committee for information, these being supplemental to the Aerodrome and Air Route Construction and Organisation plans :

(vii) Aerodrome and Air Route Operation,

(vii) Aerodrome and Air Route Maintenance.

3. **The External Air Transport Plan.**—There has been an insistent demand in the country (in the Legislature and elsewhere) that India should enter the field of international air transport. At the International Civil Aviation Conference held in Chicago in November 1944, while no agreement governing the right to operate international air services was reached, the principle was established that India, equally with other countries, has a legitimate claim to operate air services to other countries commensurate with her traffic interests in the route. The right to establish such air services has to be secured by bilateral negotiation with the countries concerned. The external air services which are proposed for initial development are on the following routes :—

(i) India to the United Kingdom,

(ii) India to the Middle East and Near East,

(iii) India to East Africa.

(iv) India to China, and

(v) India to Malaya.

None of these services can be expected to be self-supporting from the start. The capital required for operation of the first 4 air services is estimated at approximately Rs. 3 crores. The annual operating cost is estimated at approximately Rs. 2.29 crores and the revenue deficit, in the initial stage, at approximately Rs. 1.5 crores per annum. It is proposed to institute air services to the Middle East and

China as early as possible. To secure the benefits of collaboration with other British Commonwealth air services, and to enable the Indian air service to compete in the field of world air services the service to the U. K. must be of a standard comparable with the services operated on the route by other countries, *e.g.*, the U.K., U.S.A. and Australia. This air service will be operated with large modern aircraft which are not yet in service. It is considered that it will take approximately three years before India will be ready to start this service, having regard to the poor need to build up the internal air services and the time necessary to produce adequate Indian personnel trained and experienced up to the required standard. It has been suggested in the memorandum on this subject that two commercial corporations should be established for the operation of the services—one to operate services to the West and the other those to the East; and that a major interest in each of the corporations should be given to an experienced Indian air transport operator, Government taking a substantial interest, with minority interests to the other internal air operators, shipping companies and the public.

The views of the Committee are invited, in particular, on the routes proposed, the order in which they should be taken up, and on the form of operating organisation proposed.

4. **Aeronautical Training and Education.**—The importance of training and education in the development of civil aviation needs no emphasis. The plans presented to the Committee cover all aspects of this matter, including:

(a) General aeronautical education in schools and colleges;

(b) Expansion of the flying club movement;

(c) Encouragement of gliding;

(d) Establishment of an Air Service Training School with four branches,—

(i) Flying School (specialised training)

(ii) Aeronautical Engineering School

(iii) Radio School (Operators & Engineers)

(iv) Aerodrome School (Flying Control and Administration),

(e) Facilities for higher training and research in aviation in selected Universities,

(f) Arrangements for visits of civil aviation officers to other countries for advanced training, and

(g) Formation of an Aeronautical Society in this country.

The Air Service Training School is intended to produce trained personnel both for Government and commercial employment.

To secure proper direction and development of this School, it is proposed to establish an Advisory Committee in which the Government air transport operators and other prospective employers of aviation personnel will be represented. It is the intention to establish a high standard of technical training at the school and it is hoped that it will attract candidates for training from neighbouring countries, *e.g.*, Burma, Ceylon, Afghanistan, China. The cost of training, particularly in the Flying School, will be high. The Committee's views are requested, in particular, on the principles which should govern the charging of fees to students, other than those trained specifically for Government service, in the case of—

(a) Private students,

(b) Nominees of commercial employers,

(c) Nominees of Indian States.

(d) Trainees from abroad.

In regard to Flying Clubs and Gliding, the Committees' views are invited, in particular, with regard to—

(a) The adequacy or otherwise of the programme,

(b) The financial proposals as affecting the cost of flying to the individual,

(c) Suitable centres for the establishment of flying clubs.

5. **Aeronautical Radio Organisation.**—The Radio Service for Civil Aviation is at present provided by the P. & T. Department. Aeronautical Radio has become highly specialised and it is a vital part of the organisation for the operation of aircraft; it is considered essential that the service should now be an integral part of the Civil Aviation Directorate. In drawing up the post-war organisation, full account has been taken of the many improvements and developments in this field during the war. The organisation proposed is on a scale required to provide a reasonable standard of radio services for the air services proposed in the Internal Air Transport Plan and to meet India's obligations under the International Convention signed at Chicago.

6. **Aeronautical Inspection Organisation.**—This is a standing part of the Civil Aviation organisation which has the important task of supervising the airworthiness of aircraft. With the large scale development expected in the post-war period, the Inspection organisation must be expanded and suitably reorganised. The organisation proposed is set out in the memorandum submitted to the Committe.

7. **Civil Aviation Works Organisation.**—The Committee at its last meeting approved a large programme of aerodrome and air route construction, which has since been adopted by Government. The volume and special character of the works, and their intimate relationship with the operation of aircraft, makes it necessary, in the view of Government, to establish a special Aviation Works Organisation for their execution and maintenance. It is proposed to establish an Aviation Wing of the Central Public Works Department which will work alongside the Civil Aviation Directorate, in close association with the officers responsible for the planning, development and operation of the air routes. The Aviation Wing will be solely engaged on Aviation Works. The organisation proposed is detailed in the memorandum on the subject.

8. **Headquarters Organisation of the Civil Aviation Department.**—It is hardly necessary to emphasise that for the implementation of the development plans mentioned above, the organisation of the Civil Aviation Department will have to be substantially strengthened. In a rapidly developing sphere of activity like Civil Aviation, 'direction' is all important. The memorandum on this subject outlines the structure of the new organisation required at headquarters to direct and administer the various branches of aviation activity. Up to the close of the war, the head of the Department was a Director who was assisted by a Deputy Director and a few other officers in charge of the technical branches. The greatly expanded organisation needed to give effect to the policy of development of aviation in the post-war period should have at its head a Director-General, who will have under him two Deputy Directors General, one dealing with Airways and Administration and the other with Aircraft Operations. The Deputy Directors General will each be assisted by a number of Directors, each responsible for separate activities such as Air Routes and Aerodromes, Communications, Training and Licensing Air Transport Operation and Aeronautical Inspection. They will be supported by Deputy Directors and Technical Officers and adequate ministerial establishment.

A Communications Flight at Headquarters will provide the means for touring and the special work of the Department involving the use of aircraft. The personnel of the flight will provide some of the staff required for inspection of air transport operations and examination of personnel.

Particular attention is drawn to the proposal to establish an All-India Air Board with consultative and advisory functions, designed to secure the co-ordination of aviation development and administration throughout India and to maintain contact between Government and the industry. It is proposed that the Board shall comprise representatives of the Central Government, Indian States, aircraft operators and other non-officials.

The Memorandum on Civil Aviation Headquarters Organisation gives a resume of all the civil aviation post-war projects with a summary of cost (Capital and recurring) and estimates of revenue.

CIVIL AVIATION—POST-WAR PLANS

3.—External Air Services

BRIEF SYNOPSIS

1. This paper sets out proposals for the operation of the following Indian external air services:—

(a) Karachi to the United Kingdom.

(b) Karachi to the Middle East.

(c) Karachi to East Africa.

(d) Calcutta to China.

This programme gives effect to a part of the Indian programme of international air transport operation tabled at the Commonwealth Air Conference at Montreal in October 1944. It is recommended for development in stages, to give effect to the wish of the Government of India for a larger programme of air transport operation.

2. (a) *India to the U.K.*—In consequence of the decision at the Commonwealth Air Conference in Montreal in December 1944, there will be no joint operating organisation for the Commonwealth, and India is left to decide whether she will take up her right to operate a proportion of the air services on the Commonwealth air routes over which traffic from India flows. The route from India to the U. K. is the one of prime importance to India, and it is recommended that India should exercise her right to operate her quota of air services on this route, probably amounting to three services a week. The Avro Tudor II aircraft, which will be used on this service, are expected to be available in 1947. A considerable proportion of European personnel will have to be employed.

(b) *India to the Middle East.*—It would be unwise for India to enter the field of world air transport (such as a service from India to the U. K.), while neglecting and leaving to others regional air transport services to neighbouring countries. There is a number of routes with traffic potential, *e.g.*, to Iran, to the oil and trading centres in the Persian Gulf, to Iraq and possibly beyond, to Turkey, Syria, Palestine which India should explore and be prepared to operate.

(c) *India to East Africa.*—There appears to be a considerable potential volume of traffic from India to East Africa and South Africa. Shipping companies and the British Overseas Airways Corporation are known to be interested in the establishment of a direct air service between East Africa and India. The use of the new direct route along the South Arabian coast to Aden, developed during the war, effects a saving of 2,000 miles, with corresponding savings in time and cost, as compared with the established route *via* Cairo.

(d) *Calcutta to China.*—The realisation of the proximity of China and the fact that China has a western door, with the opening of the direct air route between India and China during the war and the development of the air travel habit on this route, will establish this as one of the important air routes of the world after the war. The saving in distance and time over the sea route puts it in an outstanding class. Shanghai is nearer to Calcutta than Cairo to Karachi.

The first of these services is in the category of world air services and must be operated with aircraft comparable with those used by foreign air services and preferably of the same type as those used by the British. The other three services are of a regional nature and should be operated with smaller, though modern, aircraft. Operations on the latter routes can be started with war-time transport aircraft, such as the Dakota or the DC-3.

3. *Equipment and cost.*

....	Aircraft	Capital (Rs. lakhs)	Recurring (Rs. lakhs.)	Probable annual deficit	
				Initial (Rs. lakhs)	Falling to (Rs. lakhs).
Karachi—U. K. ..	4 Tudor II	81	90	42	12
Karachi—Middle East ..	4 Air-Speed 57.	75	63	33	?
Karachi—East Africa ..	Do. ..	75	76	38	?
Calcutta—China ..	Do. ..	75	60	34	?
Total ..		306	289	147	?

The revenue, and therefore the annual deficit is, in no sense, a precise estimate. The estimate is in fact, an estimate of revenue potential, but the initial estimate is considered extremely conservative.

4. *Employment.*

....	Flying crew personnel	Engineering personnel	Total
Karachi—U. K.	30		450
Karachi—Middle East	22	120	400
Karachi—East Africa	30	120	400
Calcutta—China	20	120	370
Total ..	102	510	1620

5. *Organisation.*—For the operation of external air services, it is recommended that two commercially-managed corporations should be established, one for all operations to the West and the other for all operations to the East. These Corporations might be called Indian Western Airways, Ltd., and Indian Eastern Airways, Ltd. A substantial share interest in each corporation should be given to one experienced air transport operator; Government should take a substantial interest in the share capital, *e.g.* 20 per cent; other airlines and possibly shipping interests should be allowed to take an interest, amounting to possibly 15 or 20 per cent.; and the balance of the shares should be issued to the public. Provision should be made to restrict the transfer of shares. The authorised capital of Indian Western Airways Limited, for the operations planned, might be Rs. 3 crores, and the authorised capital of Indian Eastern Airways Limited Rs. 2 crores.

6. *Recommendations.*—It is recommended that both corporations should be formed. Indian Western Airways Limited should establish the service from India to the United Kingdom, when its operating resources have been developed, with personnel, so far as necessary, recruited from abroad. They should also start, as soon as possible, a development service, with such aircraft as are immediately available (*e.g.*, DC-3 or Dakota) on the route from Karachi to the trading and oil centres in the Persian Gulf, with a possible extension to Teheran. Indian Eastern Airways, Limited should, as an initial measure, undertake the first stage of the service to China, with a terminus possible at Kunming or Chungking. This service should be started as soon as resources permit, using such suitable aircraft as are then available (*e.g.*, Dakota or DC-3), as a development measure while plans are laid for the extension of the service to the China coast.

SECTION I—INTRODUCTION

7. Since 1933, India has participated in the operation of Commonwealth air services through the medium of Indian Trans-Continental Airways Ltd., a company in which the British Overseas Airways Corporation (originally Imperial Airways, Ltd.) hold 51 per cent. of the shares, Indian National Airways Ltd., 25 per cent. and the Government of India 24 per cent. The company owned half the fleet and operated half the air services between Karachi and Singapore until 1938. The inauguration of the Empire Air Mail Scheme in 1938 and the projected formation of the British Overseas Airways Corporation, together with the failure of the plan to provide for employment of Indians in the flying crews, lead to the conclusion that the organisation was unsuitable to India. In August, 1939, the Government of India proposed the winding up of Indian Trans-Continental Airways, Ltd., and a rearrangement of the finances of the Empire Air Mail Scheme, to permit India to operate independently the Karachi-Calcutta section of the air services terminating at Calcutta. The war prevented the examination of the proposals as well as all other development, with the result that Indian Trans-Continental Airways, Ltd., is now nothing but a small holding company. Steps are being taken to liquidate it. Apart from the operation of air services to Burma by Indian National Airways Ltd., in 1934 and 1935, and in 1942 upto the time of the evacuation, and the regular operation of Tata Air Lines to Ceylon, no Indian air services have operated outside India.

8. The position emerging from the Chicago Air Conference in November-December 1944 is that India, in common with all other countries represented at the Conference, is recognised to have an equal right with the other countries concerned to operate commercial air services between India and other territories to which traffic from India flows. No freedom for such operation is incorporated in the Convention or any of the agreements which India has signed, but the moral right of every country to operate international air transport services where it generates traffic is now an established background principle, in the light of which bilateral agreements for the establishment of foreign air services to and across India and Indian air services to and across other countries will be negotiated and framed. Apart from this, India is a signatory to the Two Freedoms Agreement, which in respect of the other countries (numbering 42 according to latest information) who have signed this agreement, incorporates the right of transit without landing and of landing for non-traffic purposes (refuelling, servicing, etc.) over and in each other's territories. At the Chicago Conference, delegations were invited to table their programme of international air transport operations, and a number of countries tabled programmes of including air services to or across India. No programme of operations was tabled on behalf of India for the reason that negotiations were in progress at the Conference for the establishment of freedom of the air for commercial air transport services coupled with international control. These discussions resulted in failure for the time being to establish the international control system which had been advocated by India.

9. At the Commonwealth Conferences in Montreal and London which took place in December following the International Conference, it was decided to establish a Commonwealth Air Transport Council for joint study and consultation on the problems of air transport in the British Commonwealth and Empire. At the same time it was decided, as a result of the desire of certain Commonwealth countries to operate their own services independently, that except in the case of a trans-Pacific air service for the operation of which a joint operating organisation owned by the United Kingdom, Australia and New Zealand is proposed, no joint Commonwealth operating organisation would be established. It follows from this decision that the operation of the air services on the air route United Kingdom—India—Australia—New Zealand, in which India has participated since 1933 through the medium of Indian Trans-continental Airways Limited, will in future be operated by such of these countries as wish to do so, by their own independent air services operating in parallel. A considerable measure of integration of these independent air services is proposed—for example, pooling of revenue and joint employment of traffic, engineering and other ground services in each other's territory.

Consequently, one of the problems calling for a decision by the Government of India is whether India will establish an independent air service between India and the United Kingdom. This is, for India, the most important of the major Commonwealth air routes, and the only one which, in the present stage of development of Indian aviation, could reasonably be contemplated in the initial post-war period. India's reciprocal right *vis-a-vis* the United Kingdom to operate a just share, based on traffic interests, of the terminal air services between the United Kingdom and India, is recognised by His Majesty's Government and it remains for India to decide whether she will take up her quota of operations. India will, in the normal course, grant operating rights to the United Kingdom and Australia for through services between England and Australia ; these services will not affect the need for services terminating in India.

10. Apart from the India—Europe—United Kingdom service, which forms a part of the Commonwealth network, the most immediate concern of India in the international air transport field is in regional air services connecting India with countries in Asia and Africa. The India delegation to the Commonwealth Air Conference were authorized to table the international air routes in which India is interested as set out in Appendix A. They were also authorised to declare India's initial programme of independent operation of international air serivces covering operations to three regions—

1. India to the Near East.
2. India to China.
3. India to East Africa.

The initial programme of international air service operation for consideration therefore consists of three regional services and the service on the Commonwealth route from India to the United Kingdom. It has also been recommended that an air service to Malaya should be included in the initial programme of operations. No specific estimates for this service have been prepared. The time necessarily required for building up an Indian air transport organisation and qualified and experienced personnel will preclude the immediate operation of all these services. Apart from this, there are technical as well as commercial factors which impose an order of priority in the establishment of these services. An Indian air transport system which concentrated on internal air services and the United Kingdom service and which neglected the regional services would be unbalanced. Some of the regional services should therefore be attempted. Each of the services is dealt with separately below :—

It should be mentioned here that the arrangements for the operation of the Services mentioned below will be subject to the negotiations of bilateral agreements with the Governments concerned who will have to be consulted through the formal official channels in due course.

SECTION II—INDIA TO THE UNITED KINGDOM

11. The services to be considered are those operating from the United Kingdom with a terminus in India. They will operate in parallel with the United Kngdom and Australian air services on the same route, passing through India to Malaya, Australia and New Zealand. Services terminating at different stages along a world route are necessary in order to deal with the traffic between those two countries, without interfering with, or being crowded out by the thrqugh traffic on the longer distance services. Before the war, under the Empire Air Mail scheme, Imperial Airways operated five services a week to India and Australia of which two had their terminus in Calcutta. A much higher frequency of service will be needed after the war. India will have the right, in agreement with the United Kingdom Government and after negotiating transit rights and so far as possible, traffic rights in the other countries on route, to operate half the services, between India and the United Kingdom. The opinion has been expressed that a frequency of 14 services a week between India and the United Kingdom (apart from the services to Australia) would be justified. It would follow that India would have

the right to operate seven services a week. Having regard to the British and Australian through services which will traverse this route and to the number of foreign air services which will also operate between India and Europe, and although the unit cost of air transport could be reduced by greater frequency, this frequency will probably be found excessive. A daily air service between London and Karachi, connecting at Karachi with the Indian internal air transport system, is considered adequate for the initial stage. Since there is a slight preponderance of eastbound over westbound traffic between the United Kingdom and India, India would claim to operate three services a week, leaving four services a week to the British Overseas Airways Corporation.

12. The aircraft selected by the British Government and the British Overseas Airways Corporation for the operation of the British services on the England-Australia route in the initial period after the war is the Avro Tudor II, a civil development of the Lancaster IV bomber. This aircraft has a total of 6720 H.P. (4 Rolls Royce Merlin); a capacity of 41 passengers by day or 22 by night; all-up weight 76,000 lbs.; cruising speed 230 miles per hour; maximum range 3,300 miles. For efficient co-ordination of the services, it is agreed that all the Commonwealth air services operating on one route should use the same type of aircraft. The Australian Government will use Tudor II's and the proposals for Indian participation are based on the same aircraft.

13. The capital required is estimated at Rs. 81 lakhs, the annual operating cost at Rs. 90 lakhs and the annual revenue at Rs. 48 lakhs rising to Rs. 785 lakhs. The main features of the service and significant points in the estimates are explained below:

(i) The estimates are based on a day and night service taking approximately 30 hours from Karachi to London, with stops in Iraq, Egypt and Italy. Alternatively the service could be operated by day, occupying two days; with a night in Cairo. Such a service would have nearly double the passenger capacity and therefore greater revenue earning capacity. The British Overseas Airways Corporation have based their proposal on the expected competition of other world air services along this rout and if India enters the field, the service must be on the same basis.

(ii) With proper integration of the British and Indian services, four aircraft are sufficient.

(iii) Provision has been made for four months working capital. The invested capital is estimated at Rs. 52 lakhs. This is based on the provisional price of the Avro Tudor II namely £58,000. Equivalent American aircraft would cost almost double the figure.

(iv) The British Overseas Airways Corporation base this estimate on a passenger fare of 4 d. per mile. This is equivalent to a fare of approximately £88 between London and Karachi. The pre-war fare was £90. The British Overseas Airways Corporation fare is a purely tentative one, pending international negotiation of fares and rates. The Indian estimate is based on a fare of 4 as. per mile which is equivalent to Rs. 1,250 or £96 from Karachi to London. While a day service with nearly double the passenger capacity could ultimately pay on this basis, it appears that a day and night service with limited passenger capacity could only pay its way at these rates if very large mail and freight loads were available to fill the available weight carrying capacity. The desirability of a day and night service, absorbing only one business day, depends on world competitive conditions. The passenger fare for such a service would have to be higher than for a day service. Passenger revenue on a Day/Night service is estimated at Rs. 31 lakhs increasing to Rs. 53 lakhs; but provided the service attracted the traffic, on a day service, the potential revenue would be Rs. 55 lakhs to Rs. 95 lakhs.

(v) Mail revenue has been estimated on the basis of a surcharge system, in conformity with the present trend of opinion in the Commonwealth postal administrations. While present indications are that this view will prevail, there is a strong body of opinion which holds that a reversion from the "all-up"

mail system, which was introduced before the war, can only be temporary. On air routes where the bulk of the mail is of the class which demands speed and can bear the high cost of carriage, world competitive factors will force modification of the mail system to an air carriage system. In the meantime a special air mail charge on a simple basis per unit of weight (to avoid the complications of the old surcharge) is considered essential. For purposes of calculation, an airmail surcharge of four annas per half-ounce within the Commonwealth and Empire and six annas per half-ounce to foreign countries is adopted. In the basis of the evidence of pre-war growth of mail, it is expected that 50 per cent. of the Commonwealth and Empire mail will go by air and that the percentage will increase to 60 per cent. within a few years. Foreign mail from India is estimated to increase from 50,000 lbs. to 60,000 lbs. within a few years—figures which are not greatly in excess of pre-war figures. Mail revenue is estimated at from Rs. 9 lakhs to Rs. 11 lakhs. The British Overseas Airways Corporation estimate is more optimistic and they may well be right.

(vi) There is, as yet, no real basis on which cargo estimates can be calculated, but air freight is universally expected to grow rapidly with the introduction of frequent, regular and faster air services. Cargo revenue is estimated at from Rs. 7 lakhs to Rs. 14 lakhs.

(vii) Total revenue on a Day/Night service is estimated at Rs. 48 lakhs to Rs. 78 lakhs; but on a Day service it might increase to Rs. 120 lakhs.

14. The service would employ nine crews consisting of Captain, First Officer, Radio Operator, Purser and two Stewards. The total staff is estimated at about 450 which would include 30 technical crew personnel; 150 engineering personnel (10 per cent. supervisory); and about 30 other senior posts—managerial operation and traffic. Some part of the staff would have to be obtained from abroad. In the early stages of operation, it may be desirable to defer the establishment of completely equipped workshops for overhaul of aircraft and engines, and to contract this work out to the British Overseas Airways Corporation, who will be equipped and manned for the purpose. This would be done mainly to facilitate starting Indian air transport operations in the major international field at an earlier stage, while the personnel and other resources are being built up in India. Combined organisations for the several Commonwealth services operating like services on the same route are, however, an essential measure of economy.

15. The agency for the operation of services overseas will be dealt with later in this memorandum. For the operation of overseas air services some form of selected agency or "chosen instrument" is likely to be essential, and, to secure the necessary unification and control, investment of Government capital is almost inevitable. On the basis of a holding of 25 per cent., Government capital required will be of the order of Rs. 20 lakhs. Whatever agency may be adopted, Government assistance in meeting the deficit will be needed. For a day and night service it appears that this will be of the order of Rs. 10 lakhs with a prospect of reduction to Rs. 10 lakhs a year, and for a purely day service, of the order of Rs. 20 lakhs per annum, with an ultimate prospect of operating at a profit. The former estimate may be improved if, on investigation, it is found that the traffic will stand a higher charge; while the latter depends for its fulfilment on an assumption that a relatively slow day service will meet the needs of a sufficient volume of traffic, in competition with other countries operating faster services.

SECTION III—INDIA TO THE NEAR EAST

16. Consideration of the problem leads to the conclusion that it would be a fatal mistake to attempt to combine the operation to the Near East with the operation of a service in the world air service class from India to the United Kingdom. The moulding of the latter to deal with the regional traffic (which will be considerable between India and the Near Eastern countries) will only result in ruining the major service and making it ineffective against its competitors. The sundry services which may be operated between India and the Near Eastern countries will have to be based on shorter stages serving a larger number of trade and population centres and, generally speaking, with aircraft of a smaller type than that to be used on the United

Kingdom service. High speed is desirable but not so all-important as in the United Kingdom service. The planning and the organisation of the Near East regional services depends very largely on the degree of commercial freedom which can be negotiated with the countries concerned.

17. On the assumption that an India-United Kingdom service is operated—in fact, in any case, if the British and foreign international air services are given 'Fifth Freedom' rights for the carriage of traffic between Egypt, Iraq and India—there would be no object in operating a slower stopping service from India all the way to Cairo, except and only on the basis that this Indian service would itself be accorded 'Fifth Freedom' rights for carriage of traffic between Egypt and other countries on the route, *e.g.*, Iraq and Iran. Dependent on the progress of negotiations for traffic rights, it may be found useful to plan an India—Near East regional air service to cover areas and places entirely untouched by the through services or between which and India, there is a considerable volume of traffic which could not be efficiently handled by the through service. Traffic to and from Bahrein is a case in point. The regional service from India to the Near East might therefore operate to such trading and oil centres, either developed or developing, as the Oman and Qatar Peninsulas, Bahrein, Bushire, Koweit, Abadan and thence to Baghdad, Palestine and Syria. Later, when Saudi Arabia opens itself to foreign air services, the Bahrein service might be extended, at least seasonally, to Riyadh, Jedda, Port Sudan and Khartoum. The precise selection of routes for such services must be determined after further study of traffic potentials, and as commerce and international intercourse in this region develops. Oil appears to be the key, and India should be ready to take her share in the air transport needed.

18. There has been a demand expressed for a service from India to Teheran. Originally it was proposed that this service should be continued to Baghdad, Palestine and Cairo, but since traffic between Teheran, Baghdad and Cairo will be served by Iranian, Iraqi and Egyptian air services, and a stopping service on a somewhat longer route would not be able to compete for long distance traffic with the direct long stage services from India along the Gulf, it now appears that the service to Teheran should be treated as the first stage in the establishment of air services to the North-West, for example to Russia and Turkey, and not as a stage in an air service to the more southerly Middle East countries, which can better be served *via* the Persian Gulf.

19. Two types of aircraft have been considered—the Curtiss C.W. 20 (civil version of the American Commando) and the Airspeed 57 (British Post-War type). Both are twin-engined aircraft, in the neighbourhood of 45,000 lbs. to 48,000 lbs. all-up weight, with a total horse-power of between 4,500 and 5,000. They have seating capacity for 35 to 40 passengers or a pay load of about 10,000 lbs.; and cruising speed varying according to operating conditions from 200 to 250 m.p.h. in the case of the C.W. 20, and 200 to 285 m.p.h. in the case of the Airspeed. Aircraft of this class appear to be desirable for the successful establishment of an air service which must compete with foreign air services and which cross long stages of desert and sea. The Airspeed has the advantage of speed with economy of engine power and the cost is likely to be 15 per cent. less than the cost of the Commando. The American aircraft has the advantage that it has been largely developed by operation of the Commando, while the Airspeed 57 is unlikely to be available until 1948. In order to start the service early after the war, it will pobably be found desirable to operate the service for a few years with disposal Dakotas, which would provide a lower standard of service with lower initial capital costs but higher intrinsic costs of operation.

20. The capital required for a service planned to operate 4 times a week is estimated at Rs. 75 lakhs with an annual operating cost of Rs. 63 lakhs. The passenger revenue earning capacity on the basis of a 66 per cent. load factor at 4 annas per passenger mile would be Rs. 64 lakhs per annum, but such a load factor could only be built up over a considerable period of operation. Mail revenue on such a route would be, comparatively, a minor factor. There would, on the other hand, be a large potential cargo revenue, in view of the slow and difficult alternative means

of transport. The aircraft would have approximately 1½ tons of pay load capacity for the carriage of mails and cargo. The aircraft contemplated for this service are intrinsically economical to operate, and the success of such an air service would depend on the extent to which traffic could be built up. Given that successful development of traffic, the air services would be self-supporting, but financial support would be needed in the early years while traffic is being developed. A service with D.C. 3 (Dakota) aircraft with a capacity of 21 passengers, very much slower and intrinsically more costly to operate, would involve capital of the order of Rs. 40 lakhs, with an annual operating cost of Rs. 40 lakhs, and would need to be operated at a load factor of 75 per cent. to break even.

21. The operation of this service would employ a total of about 400 personnel which would include 7 air crews totalling 22 technical members; 120 engineering personnel (10 per cent. supervisory); and about 25 other senior posts—managerial, operational and traffic.

SECTION IV—KARACHI TO EAST AFRICA

22. The second regional service contemplated is a direct service to East Africa *via* Aden. There will, as in the past, be an indirect service to East Africa by the British Overseas Airways Corporation and other services through Cairo, a route of 5,500 miles in length compared with the direct route of 3,400 miles. Given sufficient traffic flow, there would be a very considerable saving, both in time and cost, which would tend to divert the traffic from the longer route. The operation of the direct route has been made possible by the development of the South Arabia air route during the war—initiated and partly constructed by the India Civil Aviation Directorate for civil aviation purposes, as an alternative to the Iraq route. Except for Aden where, in addition to a certain amount of normal trade, pilgrimage services to Mecca would connect, the traffic would be almost entirely end to end traffic. The route therefore is entirely distinct in nature from the Middle East regional service. The route would be flown in comparatively long stages, except for the three traffic centres in East Africa, with one landing in Muscat territory on the south coast of Arabia, landings at Aden, Mogadishu, Mombassa, Zanzibar and Dar es Salaam, at which latter places the service would connect with local services to the interior of Kenya, Uganda and Tanganyika, as well as with the main trunk services to South Africa. Shipping interests, both in India and East Africa, are known to be interested in this service. Considerable development on some parts of the route is likely to be necessary. Route development costs are not taken into account here.

23. The aircraft required would be of similar type to those for the Middle East services, namely, medium size, fast aircraft. The capital required would amount to Rs. 75 lakhs. The annual operating cost for four services a week would be Rs. 76 lakhs. The passenger fare from Karachi to Mombassa at 4 annas per mile would be Rs. 850 or £64. The service would be comfortably flown in two days with a night stop at Aden. There would therefore be a good prospect of attracting a considerable proportion of the traffic. Mail revenue would not be an important factor, though most of the East African and South African mails would go by air on this route. Freight revenue at a charge of Rs. 3 per lb. from India to East Africa is problematical. The service would however reach the paying stage with a 66 per cent. passenger load factor. Financial assistance of the order of Rs. 35 lakhs to Rs. 40 lakhs would be required in the early years. Economies, both in equipment and personnel, would be effected by a combination of the Middle East and East African services.

24. This service would employ a staff of about 400 including 30 flight crew personnel and approximately 120 engineering staff.

SECTION V—CALCUTTA TO SHANGHAI

25. In 1940, the China National Aviation Corporation extended their Hong Kong—Chungking service *via* Kunming and Lashio to Rangoon. Tentative proposals

for the extension of the service to Calcutta were made and on the fall of Hong Kong early in 1942, they were allowed to establish their main base at Calcutta, and have since then operated commercial and military air service between Calcutta and Chungking. Reciprocal rights for an Indian company to operate an air service to Kunming were obtained in return, but an attempt to obtain rights to operate to Shanghai was not successful. The rights granted to the China National Aviation Corporation are operative only during the war, but it may be taken as certain that they will wish to operate a service to India after the war, and India will have an indisputable claim to operate a reciprocal service. China is a signatory to the Five Freedoms Agreement, but not of the Two Freedoms Agreement. Neither China nor India, therefore, will have any established right, under international agreement, to operate air services over each other's territory, and the rights will have to be negotiated.

26. Before the war the direct air route to China was unknown, and there was none but caravan traffic. After the war the situation will be metamorphosed. The direct route from Calcutta to Shanghai and Hong Kong will be one of the major air routes of the world. Shanghai is but 2,300 miles from Calcutta—a flight of 10 hours on the air services which will operate shortly after the war. The traffic flow of passengers, mails and express freight from Europe. Africa and India to China and Japan will be largely diverted from the long sea route round Singapore. From many points of view, the establishment of an air service from India to China is one of the most important external air transport problems for India. The world air services will use Constellation, D.C. 7 and Tudor Class aircraft. For India, this is a regional problem, and an air service with the same class of aircraft as those used on the Middle East and East African services would be reasonably competitive.

27. The capital cost is estimated at Rs. 75 lakhs. The annual recurring cost of a service four times a week is estimated at Rs. 60 lakhs. Passenger revenue at a 66 per cent. load factor, which might be reached in a few years, would almost cover the cost of operation. Mail and freight revenue on this service may be expected to grow rapidly. Financial assistance of the order of Rs. 30 lakhs a year, diminishing to zero in five to ten years would be required.

28. Staff employed would total about 370 including 20 flying personnel and 120 engineering personnel.

SECTION VI—OPERATING ORGANISATION AND RECOMMENDED INITIAL PROGRAMME

29. In accordance with the decision of Government, the development of internal air transport services will be left to commercial management, assisted by Government as necessary, and with an investment of Government capital and appointment of Government directors at the discretion of Government. In the case of external air services, competing with foreign air services, the national effort must be concentrated. There is no room for competition between Indian operators—at least in the major Government assisted services. At the same time, there are objections and difficulties in the selection of a single commercial operator for all the Indian external operations. The disadvantages of a single operating organisation may be mitigated by constituting different operators for different regions. It is recommended that two operating organisations should be established—one for operation from India to the West and one for operation from India to the East. These are distinct fields of operations and all the air transport operations in their respective spheres should be entrusted to these two companies. It is desirable that a major interest in each of these companies should be given to an air transport operator of proved experience, thereby ensuring experienced management. It would also appear to be desirable that the other principal operators of internal air services should be given an opportunity to take an interest in each of the companies. Shipping companies concerned in transport to the regions served, might with advantage be admitted. The public should be allowed to take a share and Government should

in each case take a substantial interest. On these lines, the division share capital in each of the two operating corporations might be as follows:—

	Capital share	*Directors*
	Per cent.	
Company	40	4
Government	20	2
Other Air Transport and Shipping companies ..	15 or 20	2
Public	25 or 20	1
	100	9

To maintain this structure, it would be necessary to limit the transfer of shares. To operate all the air services to the West, it would probably be necessary for the western corporation (Indian Western Airways Ltd.,) to have an authorised capital of Rs. 3 crores, while the eastern corporation (Indian Eastern Airways, Ltd.,) could be started with an authorised capital of Rs. 1 crore, but preferably Rs. 2 crores to allow for undertaking other operations. While the Air Transport Licensing Board will have to be satisfied before the issue of a licence, since the operating organisation will be planned by Government, there will be no question of competitive proposals for a licence to be considered by the Board.

30. Weighing up the considerations and having regard particularly to (a) the practical desirability of establishing for India a footing in international air transport, (b) the national aspirations of India to appear in the international air transport field, (c) the desirability for defence reasons, to expand the air transport programme outlined in the internal air transport plan, it is recommended that a start should be made with the following programme:—

(i) Both corporations, *i.e.*, Indian Western Airways, Ltd. and Indian Eastern Airways, Ltd., should be formed and given a preliminary programme of operations.

(ii) Indian Western Airways, Ltd. should establish a service from Karachi to England, in association with the British Overseas Airways Corporation, when it has built up adequate operating resources which it is expected will take 3 years. They should as soon as possible, establish a regional service to oil and trading centres along the Persian Gulf, with a possible extension to Teheran. This should be started with available aircraft such as Dakota or DC-3 and it should be regarded as a development measure, both of operational practice and technique and of exploration of traffic potential. The India—U.K. service will have to employ a large proportion of European personnel, but the Persian Gulf regional service should be carried through mainly by Indian personnel.

(iii) Indian Eastern Airways, Ltd. should establish the first stage of a service to China, with a terminus at Kunming or possibly Chungking. It is important that India should exercise her right to operate air services to China, in return for the concession given to the China National Aviation Corporation. This service also can be operated with D.C.3 or Dakota class aircraft, until post-war aircraft become available. The service should, like the Persian Gulf service, be regarded as a development measure, to build up operational technique and to explore traffic potential, on the basis of which further plans would be laid.

CIVIL AVIATION—POST-WAR PLANS

Aerodrome and Air Route Organisation

1. **General description.**—The functions and purpose of the Aerodrome and Air Route organisation remain substantially as they were before the war. It is the key organisation in a system of air routes. It is responsible for the administration of the aerodromes and other ground organisation not included in the special Aeronautical Radio and Meteorological services. It is a co-ordinating link between the ground services (Radio and Meteorology) and the

administrative services (Customs, Health and Police) on the one hand and the aircraft on the other. More important, however, it is responsible for the control of air traffic on the air routes and at aerodromes. While changes in system and expansion demand minor changes in staff organisation, there is no major change from the organisation established before the war. Realisation of the importance of the control of air traffic by operators has developed a tendency to demand that they should themselves control this service. Unity of control is essential and it could only be put in the hands of an aircraft operator if he were the sole operator at an aerodrome. In discussions, official and unofficial, regarding international air transport, it has been frequently urged that airports for international air navigation must be placed under international control, particularly in countries which are unable or incompetent to provide the standard of aerodrome and service required. It is the Government of India's policy to provide the ground organisation required in this country, and this policy can only be maintained by providing a first class service, capable of meeting the utmost demand made on it and satisfying the exacting demands of the operators of the international and internal air services who are responsible for the safety of their aircraft. In building up the service therefore conditions must be established which will attract the right type of men, and intensive training of all technical grades must follow. The successful handling of control duties ideally requires that the control officer should himself have years of flying experience during which he has accumulated knowledge of the ever varying problems of the air and its navigation. In India, this was not available at all before the war. To some extent the war and the building up of the Indian Air Force have remedied this. What is lacking in experience must be made up by intensive training and discipline. The assistance of a certain number of officers with experience of the most modern system of control of intensive flying built up by the Royal Air Force will be needed in this task.

2. **All India Service.**—The organisation which is proposed in this memorandum is an all-India organisation, embracing the control of air traffic both in British India and the Indian States. As in the Air Transport plan and the programme of Air Route and Aerodrome construction submitted to Government, so in this, the air can only be dealt with as a national problem. It cannot be organised as a patchwork of small territorial units. Air traffic control is essentially a unified problem and a unified service is required. In what follows therefore staff is provided for control duties at the essential aerodromes in Indian States. There is nothing however to prevent a State providing its own aerodromes with hangers, workshops, control buildings and other ancillary services, and in such a case the State will provide its own administrative staff. In a case where the Government of India provides an aerodrome in State territory the whole of the staff will have to be provided by Government. This is in accordance with the principles embodied in the Foreign and Political Department Resolution dated 8th August 1932 governing aviation in the States and with the agreement reached with the Jodhpur Darbar before the war, for the assumption of responsibility for control at Jodhpur by the Government of India. To the extent that the States themselves provide aerodrome and administrative staff, the size and cost of the organisation now outlined will be reduced.

3. **Period of development.**—Like the air transport plan and the construction programme this is a long term, or at least a medium term programme. It is based on the manning of the system of air routes and aerodromes, to be constructed in the period of 10 years following the war, for the operation of the international and internal air services which will come into operation during that time. While construction will continue throughout the period of ten years and after, this does not mean that the air routes will not be ready for operation before. The full system of air services is expected to come into operation within five years, and the Aerodrome Service outlined herein may be regarded as one to be built up within that period. Necessary training would preclude its establishment at once.

4. **Annexures.**—The following schedules are annexed:—

I. Schedule of Aerodromes and Landing Grounds. (Classified by Routes).

II. Regional Division of the Aerodrome Organisation.

III. Schedule of Aerodrome Operational Staff Required.

5. **Classification of Aerodromes.**—(*i*) The aerodrome organisation proposed comprises 111 aerodromes and landing grounds which will serve the 11 scheduled routes and also a number of towns lying outside the scheduled routes but considered essential for general communications. A provisional schedule of the aerodromes is given in Annexure I. The aerodromes have been classified into 4 International, 14 Major, 34 Intermediate and 59 Minor aerodromes. This classification will not remain stable but will be sufficiently so to enable the total operational staff and equipment to be computed on broad lines.

(*ii*) International aerodromes are "super-standard" aerodromes, fully organised in every respect to receive international air transport in addition to internal air services. Major aerodromes are the principal aerodromes at which internal air services will land. Intermediate aerodromes are the more important aerodromes on scheduled routes at which landings will not regularly be made, plus a number of aerodromes at important towns not served by these routes. The intermediate aerodromes include also some of the regular stops on subsidiary routes where traffic for some years will not be of such magnitude as to justify their staffing and equipment as major aerodrome. Minor aerodromes are aerodromes which will be used in emergency by the regular services and which will also be used as refuelling stops by short-range aircraft flying over the routes.

6. **Regional Organisation.**—(*i*) It is no longer possible for a single officer to exercise supervision over the control organisation and administration of the aerodromes throughout India, and it is proposed to abolish the existing post of Chief Aerodrome Officer. The division of the aerodrome organisation into six Regions each under a Regional Aerodrome officer is proposed, in order to provide the most efficient organisation. The main considerations which have been borne in mind are,—

(*a*) the necessity of bringing together into one focus in each Region the three branches of the aeronautical ground services, *viz.* aerodrome organisation, radio service and meteorological service; and

(*b*) the sub-division of the aerodrome organisation into areas of such a size that they can be effectively inspected and administered by the Regional Officer responsible.

The six regional headquarters will be at Karachi, Delhi, Calcutta, Bombay, Nagpur and Madras. This is in line with the meteorological organisation proposed by the Director-General of Observatories and the radio organisation separately proposed. The aerodromes and landing grounds located in each Region are shown in Annexure II.

7. **Operational Staff.**—(*i*) The two chief functions of an Aerodrome Officer are flying control and administration. Control Officers will be provided at all international, major and intermediate aerodromes, their numbers varying according to the intensity of traffic and hours of service. At the more important aerodromes there will also be an officer in general charge. Administration, though important, is secondary to flying control and will be exercised to a large extent through the Regional Offices, the object being to relieve the Control Officers of administrative duties so that they may devote the fullest attention to flying operations. Operational duties at minor aerodromes are not of sufficient responsibility to justify the service of an Officer. These aerodromes will be placed under the control of a Supervisor who will carry out minor administrative and maintenance duties as well as operational duties.

(*ii*) Annexure III shows the total operational staff estimated to be required,

Paragraph 10 shows the estimated cost. It is emphasised that these estimates are provisional and are based on averages for each class of aerodrome; a meticulously accurate assessment of staff for every aerodrome and landing ground is impossible. Individual variations from the average will be made as circumstances dictate.

(*iii*) The international aerodromes and some of the major aerodromes will be provided with staff on a full 24 hours basis. The remaining aerodromes will be staffed according to the actual hours of operation of the regular services proposed and the general operational and administrative requirement. Whilst all foreseeable factors have been taken into consideration in assessing the hours of service required, there is a possibility that development of traffic and multiplication of services will enforce an expansion of staff in order to provide a full 24 hours' watch at aerodromes which have not at present been placed in this category.

(*iv*) The following brief explanation is given of the new grades of staff and certain revisions of pay of existing staff which will be required in the aerodrome organisation to meet the larger scale and more exacting conditions of post-war operations.

(*a*) *Regional Aerodrome Officer.*—The Regional Aerodrome Officer will be responsible for the efficient co-ordination of the ground organisation provided for the safety and regularity of aircraft operations within his Region and for the administration of the aerodromes and landing grounds therein. Essentially, he will be an inspecting officer who will carry out regular tours of all stations in the Region. It will be his duty to ensure that effective co-ordination is maintained between the aerodrome organisation and the Radio, Meteorological and Works services and also between the aerodrome organisation and such associated services as Health, Customs, Passports and Posts. It follows that this officer must hold a status equivalent to that of officers exercising similar regional responsibilities in the other services.

(*b*) *Aerodrome Officer, Grade II, and Assistant Aerodrome Officer.*—An improvement in the scales of pay of Aerodrome Officers, Grade II, and Assistant Aerodrome Officers is considered necessary. In order to attract experienced control officers who may be released from the Indian Air Force, and having regard to the limited opportunities for promotion from A.A.O., to A.O., Grade II, it is proposed to extend the scale of pay of the A.A.O. from 200—15—350 to 200—15—350—25—500. The Aerodrome Officer, Grade II, will occupy in the new organisation a post of greater responsibility than in the past. It is proposed to advance his scale of pay from 350—25—550 to 400—25—600.

(*c*) *Assistant Aerodrome Officer* (*Administration*).—At a busy aerodrome, minor administrative matters which require attention by an officer are arising continuously throughout the day. The need for an Assistant Aerodrome Officer for administrative duties has long been felt. In the first instance, such officers will be appointed in the six aerodromes where Regional Headquarters will be established, *viz.* Karachi, Delhi, Calcutta, Bombay, Nagpur and Madras. These officers will be taken from the regular cadre of Assistant Aerodrome Officers and will be posted for this duty from time to time.

(*d*) *Signaller.*—The Signaller will combine most of the duties carried out at an R.A.F. aerodrome by the "Airfield Controller" and the "Lookout", both of whom work under the Flying Control Officer. He will be the right-hand man of the control Officer, responsible for keeping a continuous lookout for approaching aircraft or for any abnormal occurrence on the aerodrome, and for signalling instructions to aircraft under the orders of the Control Officer.

(*e*) *Control Operator.*—The work of the existing Control Clerks at aerodromes is becoming increasingly specialised and this process will continue. It is proposed to introduce a special grade of Control Operator who must be trained to the necessary standard of operational knowledge and practical ability. The chief duties of the Control Operator are to receive, distribute and record all

messages connected with aircraft operations, to maintain operational logs and records and to provide uninterrupted and intelligent service by telephone in the Control Room for all operational purposes.

(*f*) *Traffic Foreman and Traffic Hands.*—The normal duties of the Traffic Foreman will be attendance on aircraft arriving and departing; parking, housing and picketting of aircraft; laying out signals; ground markings and emergency night lighting; upkeep of emergency night lighting (oil lamps and flares) etc. In addition, the Traffic Foreman will be in charge of the aerodrome fire and crash party and will be responsible for the state of readi. ess of fire and crash equipment. It is essential that the traffic hands should be men of a type superior to the cooly class hitherto employed. The duties demand the recruitment of men possessing a higher standard of intelligence and the scale of pay has been raised accordingly.

(*g*) *Airfield Supervisor.*—The subordinate placed in charge of a minor aerodrome should possess elementary knowledge of aircraft operations so that he can give necessary service to visiting aircraft, *i.e.*, displaying of ground markings and signals; picketting of aircraft; laying out of emergency lighting for night landings; supplying meteorological report and other information; assistance in starting up aircraft; reports to control aerodrome of arrivals and departures; collection of landing fees, etc. As the duties will vary according to the importance of the aerodromes, two grades of Supervisors are proposed. The men selected will be of the N. C. O. or Overseer type. In addition to operational duties, they will be responsible for the control of the cooly gang employed on the maintenance of the aerodrome and other minor maintenance and administrative duties.

(h) *Regional Headclerk.*—A Headclerk superior in status to the Senior Clerk at an aerodrome will be required in each Regional Office. He will be responsible for accounts, establishment matters and general supervision of clerical and store-keeping duties within the Region.

(i) *M/T Foreman and Fitter Drivers.*—Mechanical equipment of a mobile type employed in connection with aircraft operation—*i.e.* ambulances, vans tractors, fire engines, mobile floodlights, etc.—will be operated and maintained by the staff of the aerodrome organisation. The works organisation will be responsible for the operation of all fixed mechanical and electrical equipment at aerodromes and also for their own mobile equipment. Each of the six regions of the aerodrome organisation will have an M/T Foreman and workshop staff capable of undertaking major overhauls and repairs to aerodrome mobile equipment. The existing grades of Motor Driver Grade I and Grade II will be replaced by new grades of Fitter Driver and Driver on the same rates of pay. At international and major aerodromes the Fitter Drivers will carry out normal maintenance and repair work. At intermediate and minor aerodromes, where Drivers only will be stationed, periodical inspection and maintenance will be carried out by the M/T foreman and workshop staff who will carry out tours for this purpose.

(j) *Police.*—Police are required at International and Major aerodromes for the maintenance of public order including watch and ward in the embarkation area, control of road traffic, control of visitors and general police duties. So far as the police are employed for watch and ward within the aerodrome, the cost of their services is a charge against the Central Government. Police provided at aerodrome for passport and immigration duties, control of road traffic and policing of residential areas are the reponsibility of the Provincial Government. Experience at Karachi Airport has shown that co-ordination is readily arranged between the police employed on 'Central' and 'Provincial' duties and that the Provincial authorities are willing to pr vide extra police on special occasions, when large crowds are likely to assemble at the aerodrome. The small police units which are required permanently at aerodromes for watch and ward duties at the cost of the Central Government are included in Annexure III. The establishment of a cadre of Aerodrome Police on the parallel of Railway Police is not justified at present, although this is a probable development later.

8. **Training School.**—Separate proposals are being prepared for the establishment of a Civil Air Service Training School. One of the four sections of this School will be the Aerodrome School. Here will be trained the Aerodrome Officers, both in administration and flying control duties. Such a school was established at Karachi before the war and all new entrants to the service (Assistant Aerodrome Officers) were given a six months course before being posted for duty. It is possible that the post-war course will be longer, dependent on the type of recruit obtained. The School will also give refresher courses from time to time to keep control officers up-to-date and the system unified. Training in the School after the war will be extended to a number of the specialist subordinate grades, including Signallers, Control Operators, Airfield Supervisors and Traffic Foremen. An experienced flying control officer will be placed in charge.

9. Medical Attendance and Amenities in Residential Colonies.—In view of the remote situation of many aerodromes and the lack of facilities for medical attendance to the resident staff, some provision must be made for their health. At the outset the aerodrome organisation will not be big enough to justify the setting up of a separate aerodrome medical service, and it will be necessary to make arrangements for medical supervision and attendance either through the D.G., I.M.S., or through the local health authorities. Co-ordination will be possible between the health staff provided at international aerodromes in connection with yellow fever precautions and the health staff necessary for the well-being of the residential colony; such co-ordination has already taken shape at Karachi Airport. It is considered that where an aerodrome lies outside Municipal limits and the residents at the aerodrome exceed 200, the services of a Sub-Assistant Surgeon and a Compounder should be made available and that, where the number exceeds 1000, a small hospital should be established with a staff of, say, one Sub-Assistant Surgeon, one Sanitary Inspector, two Compounders and one Nurse. Where the residents number more than 50 but less than 200 a compounder will be sufficient. As this is a Health service no provision is made for the staff in these proposals. To preserve the health and well being of the staff in large colonies, it is necessary that some means of transport to the nearest centre should be provided, for example by public bus services, if necessary assisted by Government; and it is desirable that organised recreation should be assisted.

10. **Summary.**—(1) The staff organisation projected is compared with the existing organisation below:

	Existing	Projected
Officers	34	138
Subordinates	110	1032
Inferior staff	38*	623
Police	..	46
Annual cost	Rs. 2,59,400	Rs. 17,16,000

*Traffic Hands and other Inferior staff are at present employed on a temporary basis as 'work charged' staff.

(ii) The additional posts which are regarded as suitable for the employment of ex-officers and service men are shown in the following table:—

Post	Number	Type of ex-service officer or man
Officers		
Assistant Aerodrome Officers ..	104	Experienced Indian Air Force Pilots.
Subordinates		
Signallers	50	English speaking N. C. O's and men from the Signals services of the I. A. F., R. I. N. or Army.
Control operators	170 approx.	
Airfield Supervisors	65	English speaking N. C. O's. from the the I. A. F.
M/T Foremen, Fitter Drivers, Drivers, Coachpainters	290	M/T Drivers and Mechanics from the Army or Air Force.
Clerks, Typists, Storekeepers ..	130 approx.	Indian clerks, typists, etc., from any service.
Traffic Hands	230	Intelligent N .C. O's. or men of the Indian Air Force.
Subordinate—Total	935	
Inferior Staff— Caretakers, Chowkidars, Poons, Cleaners, etc. ..	450	Ex-soldiers.
Total prospective employment of ex-service men in the Aerodrome Service		Officers .. .. 104 Subordinates .. .. 935 Inferior Staff 450

PART 4.—ANNEXURE I

Provisional Schedule of Aerodromes and Landing Grounds Summary.

(Classified by routes)

Routes	International	Major	Intermediate	Minor
Karachi-Colombo	2	2	3	8
Calcutta-Kabul	2	4	4	2
Jiwani-Karachi-Delhi	..	1	1	5
Bombay-Calcutta	..	1	3	3
Calcutta-Colombo	..	2	2	7
Delhi-Madras	..	1	3	5
Bombay-Delhi	..	1	1	4
Calcutta-Rangoon	..	..	1	1
Karachi-Quetta-Lahore	..	..	3	5
Calcutta-Dinjan	..	..	3	2
Madras-Bangalore-Cochin	..	..	1	2
Additional aerodromes	..	2	9	15
Total (111)	4	14	34	59

Provisional Schedule of Aerodromes and Landing Grounds

(Classified by routes)

Route Serial No.	International	Major	Intermediate	Minor	Remarks
		I. KARACHI—COLOMBO			
1	Karachi (Mauripur)	..	..	..	R. A. F. aerodrome.
2	..	..	..	Mughal Bhim	D. C. A. landing ground.
3	..	..	..	Bhuj (Rudramula)	R. A. F. aerodrome in State territory.
4	..	..	Jamnagar (Chela)	..	Do.
5	Bombay (Santa Cruz)	..	..	..	D.C.A. aerodrome extended by R.A.F.
6	..	Poona (Lohegaon)	..	..	Do.
7	..	..	..	Kolhapur.	State landing ground.
8	..	..	Belgaum (Sambre)	..	R. A. F. aerodrome.
9	..	..	..	Hubli	New landing ground proposed.
10	..	..	..	Bellary	R. A. F. aerodrome.
11	..	..	..	Chitaldroog.	New aerodrome proposed in State territory.
12	..	Bangalore	..	..	State aerodrome developed by R. A. F.
13	..	..	..	Salem	New aerodrome proposed.
14	..	..	Trichinopoly	..	D. C. A. aerodrome extended by R.A.F
15	..	..	..	Ramnad	D. C. A. landing ground.
		II. CALCUTTA—KABUL			
1	Dum Dum (Calcutta)	..	..	..	D. C. A. aerodrome extended by R.A.F.
2	..	..	Asansol	..	R. A. F. aerodrome.
3	..	..	Gaya	..	D. C. A. aerodrome.
4	..	..	Benares (Rajwari)	..	R. A. F. aerodrome.
5	..	Allahabad	..	..	D. C. A. aerodrome extended by R.A.F.
6	..	Cawnpore (Chakeri)	..	..	R. A. F. aerodrome.

Route Serial No.	International	Major	Intermediate	Minor	Remarks
7	..	..	..	Aligarh	New aerodrome proposed.
8	Delhi	..	..	..	D. C. A. aerodrome extended by R.A.F.
9	..	..	..	Ludhiana (Halwara)	R. A. F. aerodrome.
10	..	Lahore (Walton)	..	..	D. C. A. aerodrome extended by R.A.F.
11	..	..	Rawalpindi (Chaklala)	..	R. A. F. aerodrome.
12	..	Peshawar	..	..	R. A. F. aerodrome.
		III. JIWANI—KARCHI—DELHI			
1	..	..	Jiwani	..	D. C. A. landing ground in State territory.
2	..	..	..	Pasni	Do.
3	..	..	..	..	Karachi (See Route No. I Karachi—Colombo).
4	..	..	..	Hyderabad (Bholari)	R. A. F. aerodrome.
5	..	..	..	Dharo Naro (Chor)	R. A. F. aerodrome.
6	..	..	..	Uterlai	State landing ground.
7	..	Jodhpur	..	..	State aerodrome.
8	..	..	..	Sikar	New aerodrome proposed in State territory.
9	..	..	..	..	Delhi. See Route No. II Calcutta—Kabul.
		IV. BOMBAY—CALCUTTA			
1	..	..	..	..	Bombay (Santa Cruz) (See Route No. I Karachi—Colombo).
2	..	..	Aurangabad	..	State aerodrome extended by R.A.F.
3	..	..	..	Akola	D. C. A. aerodrome extended by R. A. F.
4	..	Nagpur	..	..	Do.
5	..	..	..	Raipur (Mana)	Do.
6	..	..	Jharsuguda	..	Do.

Route Serial No.	International	Major	Intermediate	Minor	Remarks
7	..	..	Jamshedpur	..	Private landing ground, proposed to be developed by D.C.A.
8	..	..	..	Kharagpur	R. A. F. aerodrome.
9	..	..	..		Calcutta (Dum Dum) (See Route No. II Calcutta—Kabul).
		V. CALCUTTA—COLOMBO			
	..	..	..	..	Calcutta (Dum Dum) (See Route No. II Calcutta—Kabul).
2	..	..	..	Amarda Rd.	R. A. F. aerodrome.
3	..	..	Cuttack or Bhubaneshwar.	..	D. C. A. aerodrome extended by R.A.F. or R.A.F. aerodrome.
4	..	..	..	Berhampur	New aerodrome proposed.
5	..	..	..	Vizianagaram	Private aerodrome extended by R.A.F.
6	..	Vizagapatam	..	..	D.C.A. aerodrome extended by R.A.F.
7	..	..	..	Rajahmundry (Godavari)	R. A. F. aerodrome.
8	..	..	Bezwada (Gannavaram)	..	Do.
9	..	..	..	Nellore ..	New aerodrome proposed.
10	..	Madras St. Thomas Mt.)	..	..	D.C.A. aerodrome extended by R.A.F.
11	..	..	..	Cuddalore	New aerodrome proposed.
12	..	..	..	Tanjore	R.A.F. aerodrome.
13	..	..	..	..	Trichinopoly (See Route No. I Karachi—Colombo).
14	..	..	..	..	Ramnad (See Route No. 1 Karachi—Colombo).
		VI. DELHI—MADRAS			
1	..	..	..	..	Delhi. (See Route No. III Karachi—Delhi).
2	..	..	Agra	..	R.A.F. aerodrome.
3	..	..	Gwalior (Maharajpur)	..	R.A.F. aerodrome in State territory.
4	..	..	..	Jhansi	R.A.F. landing ground.

Route Serial No.	International	Major	Intermediate	Minor	Remarks
5	..	..	..	Lalitpur	R.A.F. aerodrome.
6	..	..	..	Saugor	New aerodrome proposed.
7	..	..	Bhopal (Bairagarh)	..	State aerodrome extended by R.A.F.
8	..	..	..	..	Nagpur. (See Route No. IV Bombay—Calcutta).
9	..	..	..	Adilabad	State aerodrome extended by R.A.F.
10	..	Hyderabad (Begumpet)	..	..	State aerodrome.
11	..	..	..	Donakonda	D.C.A. landing ground.
12	..	..	..	..	Nelloro. (See Route No. V Calcutta—Colombo).
13	..	..	..	..	Madras (St. Thomas' Mt.). (See Route No. V Calcutta—Colombo).
		VII. BOMBAY—DELHI			
1	..	..	..	..	Bombay (Santa Cruz). (See Route No. I Karachi—Colombo).
2	..	..	..	Surat	New aerodrome proposed.
3	..	..	..	Baroda	State aerodrome extended by R.A.F.
4	..	Ahmedabad	..	..	D.C.A. aerodrome extended by R.A.F.
5	..	..	..	Udaipur	New aerodrome proposed.
6	..	..	..	Ajmere	Do.
7	..	..	Jaipur (Sanganer)	..	State aerodrome to be extended.
8	..	..	..	..	Delhi. (See Route No. II Calcutta—Kabul).
		VIII. CALCUTTA—RANGOON			
1	..	..	..	..	Calcutta (Dum Dum) (See Route No. II Calcutta—Kabul.)
2	..	..	..	Jessore	R.A.F. aerodrome.
3	..	..	Chittagong	..	D.C.A. aerodrome extended by R.A.F.

Route Serial No.	International	Major	Intermediate	Minor	Remarks
		IX. KARACHI—QUETTA—LAHORE.			
1	..	..	..	..	Karachi (Mauripur). (See Route No. I Karachi—Colombo).
2	..	..	..	..	Hyderabad (Bolari). (See Route No. III Karachi—Delhi).
3	..	..	..	Nawabshah	R.A.F. aerodrome.
4	..	..	..	Pad Idan	R.A.F. landing ground.
5	..	..	Jacobabad	..	D. C. A. aerodrome extended by R.A.F.
6	..	..	..	Sibi	R. A. F. aerodrome.
7	..	..	Quetta (Samungli)	..	R.A.F. aerodrome.
8	..	..		Loralai	R. A. F. landing ground.
9	..	..	Multan	..	D. C. A. aerodrome extended by R.A.F.
10	..	..	..	Montgomery	R. A. F. landing ground.
11	..	..	..	..	Lahore. (See Route No. II Calcutta—Kabul).
		X. CALCUTTA—DINJAN			
1	..	..	..	..	Calcutta (Dum Dum). (See Route No. II Calcutta—Kabul).
2	..	..	..	..	Jessore. (See Route No. VIII Calcutta—Rangoon).
3	..	..	Dacca (Tezgaon)	..	R.A.F. aerodrome.
4	..	..	Sylhet	..	*Do.*
5	..	..	..	Lanka	R. A. F. landing ground.
6	..	..	..	Jorhat	R. A. F. aerodrome.
7	..	..	Dinjan	..	R.A.F. aerodrome.
		XI. MADRAS—BANGALORE—COCHIN			
1	..	..	..	..	Madras (St. Thomas Mt.). (See Route No. V. Calcutta—Colombo).
2	..	..	..	Vellore	New aerodrome proposed.
3	..	..	..	..	Bangalore (Yelahanka). (See Route No. I Karachi—Colombo).
4	..	..	..	Coimbatore (Sulur)	R.A.F. aerodrome.
5	..	..	Cochin	..	D.C.A. aerodrome extended by R.A.F.

ADDITIONAL AERODROMES NOT ON SCHEDULED ROUTES

Serial No.	State or Province	International	Major	Intermediate	Minor	Remarks
1	Assam ..	..	..	..	Gauhati	New aerodrome proposed.
2	Bengal ..	..	..	..	Dinajpur (Shibganj)	R.A.F. aerodrome.
3	„ ..	..	..	..	Jalpaiguri	Private landing ground to be taken over and developed by D.C.A.
4	Bihar ..	..	Patna (Bikram)	..	..	R.A.F. aerodrome.
5	„ ..	..	..	Ranchi	..	R.A.F. aerodrome.
6	Bombay ..	..	..	..	Ratnagiri	New landing ground proposed.
7	„ ..	..	..	..	..	R.A.F. landing ground.
8	Central Provinces.	..	..	..	Jubbulpore	R.A.F. landing ground.
9	Indore ..	..	..	Indore	..	State landing ground.
10	Kashmir ..	..	..	Srinagar	..	do.
11	Kathiawar ..	..	..	..	Rajkot	do.
12	Madras ..	..	..	Ootacamund	..	New aerodrome proposed.
13	„ ..	..	..	..	Madura	R.A.F. aerodrome.
14	„ ..	..	..	..	Calicut	New aerodrome proposed.
15	„ ..	..	..	Mangalore	..	do.
16	„ ..	..	..	..	Cuddapah	D.C.A. landing ground.
17	„ ..	..	..	..	Tinnevelly (Kayathur)	R.A.F. aerodrome.
18	Mysore ..	..	..	Mysore	..	State landing ground.
19	Punjab ..	..	..	Kalka	..	New aerodrome proposed.
20	Rajputana States. ..	..	..	..	Bikaner	R.A.F. aerodrome in State Territory.
21	Trivandrum State.	..	..	Trivandrum.	..	State landing ground.
22	United Provinces.	..	..	Dehra Dun	..	New aerodrome proposed.
23	„ ..	..	..	..	Bareilly (Izatnagar)	R.A.F. aerodrome.
24						
25	„ ..	..	..	..	Saharanpur	do.
	„ ..	..	Lucknow (Amausi)	..		do.
26	„ ..	..	..	..	Gorakhpur (Kusmi)	do.

PART 4.—ANNEXURE II

Regional Division of the Aerodrome Organisation

(Provisional)

Karachi	Delhi	Calcutta	Bombay	Madras	Nagpur
1. *International*	1. *International*	1. *International*	1. *International*	1. *International*	1. *International*
Karachi	Delhi	Calcutta	Bombay	..	..
				..	..
2. *Major*	2. *Major*	2. *Major*	2. *Major*	2. *Major*	2. *Major*
Jodhpur	Allahabad	Patna	Poona	Madras	Nagpur
	Cawnpore		Ahmedabad	Bangalore	Hyderabad
	Lahore			Vizagapatam	
	Peshawar				
	Lucknow				
3. *Intermediate*	3. *Intermediate*	3. *Intermediate*	3. *Intermediate*	3. *Intermediate*	3. *Intermediate*
Multan	Gwalior	Gaya	Sambre	Trichinopoly	Jharsaguda
Jiwani	Rawalpindi	Cuttack	Jamnagar	Bezwada	Bhopal
Jacobabad	Agra	Chittagong	Aurangabad	Cochin	Indore
Quetta	Jaipur	Dinjan		Ootacamund	
	Srinagar	Asansol		Trivandrum	
	Kalka	Jamshedpur		Mangalore	
	Dehra Dun	Dacca		Mysore	
		Sylhet			
		Ranchi			
		Benares			
4. *Minor*	4. *Minor*	4. *Minor*	4. *Minor*	4. *Minor*	4. *Minor*
Moghul Bhim	Aligarh	Kharagpur	Kolhapur	Bellary	Hyderabad
Bhuj (Rudra-mala)	Ludhiana (Halwara)	Jessore	Hubli	Chitaldrug	(Bholari)
Pasni	Sikar	Jorhat	Surat	Salem	Akola
Dharo Naro (Chor)		Gauhati	Baroda	Rammad	Raipur (Manar)
Uterali	Ajmere	Dinajpur (Shibganj)	Ratnagiri	Berhampur (or Gopalpur)	Jhansi
Udaipur	Montgomery	Jalpaiguri	Sholapur	Vizianagram	Saugar
Nawabshah	Bikaner	Gorakhpur (Kusmi)	Rajkot	Rajahmundry (Godavari)	Adilabad
Pad Idan	Bareilly (Izatnagar)	Sanka		Nellore	Lalitpur
Sibi	Saharanpur	Amarda Rd.		Cuddalore	Jubbulpore
Loral				Tanjore	
				Donakonda	
				Vellore	
				Coimbatore (Sulur)	
				Madura	
				Calicut	
				Cuddapah	
				Tinnevelly (Kayathur)	

PART 4.—ANNEXURE III

Schedule of Aerodrome Operational Staff Required

(Provisional)

Stations (class)	Regional (International)	Regional Major	Major	Intermediate	Minor	Training School	Total	Leave Reserve 10%	Grand Total
Number	4	2	12	34	59	1	112	..	112
STAFF									
Superior		R A	R A						
R. A. O.	4	2	..	..	..	..	6	..	6
A. O. I.	4	2	..	..	..	1	7	..	7
A. O. II	..	..	12	..	..	1	13	..	13
A. A. O. (Administrative)	4	2	..	..	..	..	6	..	6
A. A. O. (Control)	16	8	22	48	..	..	94	12	106
Subordinate									
Signaller	12	6	24	..	..	2	44	6	50
Control Operator	24	8	43	102	..	..	177	25	202
Floodlight Operator (Mobile)	..	..	12	..	..	..	12	1	13
Traffic Foreman	12	4	19	14	..	..	49	7	56
Traffic Hands	36	12	38	68	..	..	154	22	176
Airfield Supervisor I	..	..	..	..	34	..	34	..	34
Airfield Supervisor II	..	..	..	..	25	..	25	6	31
Head Clerk	4	2	..	..	..	..	6	..	6
Senior Clerk	4	2	12	14	..	..	32	..	32
Steno-typist	4	2	..	..	..	..	6	..	6
Storekeeper	4	2	..	..	..	..	6	..	6
Junior Clerk	16 12	8 6	19	34	..	..	95	14	109
M/T Foreman	4	2	..	..	..	..	6	..	6
M/T Fitter Driver	8 4	4 2	12	..	..	..	30	28	30
M/T Driver	32	14	54	82	59	..	241	28	269
M/T Coach Painter	4	2	..	..	..	..	6	..	6
Inferior									
Khalasee (M/T)	8	4	..	..	..	..	12	..	12
Cleaner (M/T)	4 8	2 4	12	..	..	..	30	..	30
Storeman	4	2	12	..	..	..	18	..	21
Daftri	4 4	2 2	3	..	..	..	15	..	15
Caretaker	8	4	7	..	..	..	19	..	19
Chowkidar	20	10	26	68	..	..	134	..	134
Duffadar	4	2	..	..	..	..	6	..	6
Peon	4 24	2 12	51	136	..	..	229	..	229
Sweeper	4 32	2 12	39	68	..	..	157	..	157
Police									
Head Constable	4	2	12	..	..	..	18	..	18
Constable	12	4	12	..	..	..	..	..	28

R = Regional Office.
A = Aerodrome Office.

CIVIL AVIATION—POST-WAR PLANS.

5—Aeronautical Radio Service.

INTRODUCTION

Dr. Edward Warner in his 1943 Wilbur Wright Memorial lecture said "Post-war Radio will be scarcely a recognizable relation of its pre-war predecessor". In no branch of aeronautical science has greater development taken place in the last few years and particularly during the war than in the application of radio to the specialised communication and navigation needs of aircraft operation. So great has been this development and so imperative is the need for keeping up-to-date that it has virtually rendered obsolete the whole of the aeronautical wireless system in India. Developments have taken place under the combined Civil and Service aeronautical wireless service to meet war-time transport and reinforcement requirements, and these developments have been taken into account in the proposals made herein. At the recent Commonwealth and Empire Conference on Radio for Civil Aviation, information was released for the first time to Civil Aviation authorities on the latest radio developments for air navigation. This conference, the first of a series of Empire, Allied and International Conferences, agreed to a list of types of air and ground systems which could be employed in the immediate post-war period. In considering plans for standard post-war systems the conference could not go further than agree to proposals for standardization of systems to be considered at the first International Aeronautical Conference. A list of systems was also agreed, whose present status was promising and which merited continued development for introduction in due course where they offered substantial advantages over systems then in use. In considering the plans for the immediate post-war period the conference took into account the proposals for later international standardization of equipment and wherever possible systems were selected which would facilitate the international introduction of the standard equipment. The re-organisation of the Civil Aeronautical Radio Service in India and a very considerable expansion will be an immediate necessity when war conditions permit—if India is to take any effective steps to establish the position in the aeronautical world which she claims, both as a country which willy-nilly figures largely in the problem of world air transport and as a country which desires an internal air transport system commensurate with her world position and size.

2. The proposals made herein, however, only cover a period of, say, five years from the end of the war or what might be termed the immediate post-war period. Consideration is limited to facilities which are available at the time of the preparation of the paper and which include types of equipment which now exist or could be rapidly modified to Civil Aviation needs. At the end of the 5-year period, it is hoped, international agreement will have been reached on standard system and countries will be in a position to implement the decisions then taken. It should be noted, however, that the apparatus and systems affected by the final plans are likely to be in the nature of additions to those adopted in the interim plan and the reaction of the final plans will be greatest on the international routes.

3. The specialised character of an aeronautical radio service demands that it shall be organized as a service under the direction of the Director of Civil Aviation and that the whole of this service—material and personnel—administration, operation and engineering—shall be devoted to the one object of providing a safe and efficient service for aviation and for this purpose specialised personnel will have to be engaged to develop and control this system. Post-war development of Aeronautical Radio service will therefore be dealt with under two heads.

I. Modernization of the equipment and expansion of the organisation to cover the new routes which will come into operation.

II. The organisation of a separate aeronautical wireless service directly under the Director of Civil Aviation.

SECTION I—EXISTING EQUIPMENT

1. As a stepping off point it will be useful to recapitulate the organisation as it now exists. The service is provided by the Posts and Telegraphs Department and that Department provides all material (buildings and apparatus), administers the service and employs all the personnel, including operational staff and engineering staff. The recurring cost of this service, including depreciation and interest on capital is credited from the Civil Aviation Department budget to the Posts and Telegraphs Department by annual budget adjustments. The cost in 1941-42 was Rs. 11,07,500. A combined Civil and Service Wireless organis..tion was subsequently formed to meet increased war-time requirements and the cost of the service in excess of the average cost of the service in the years 1939-40, 1940-41, and 1941-42 is debited to the War Department as the Services contribution. The initial capital value of the aeronautical wireless stations in India established on the 31st March, 1943 was as follows:—

		Rs.
1.	Ahmedabad	1,53,648
2.	Allahabad	2,66,328
3.	Bangalore	73,027
4.	Bombay	4,69,113
5.	Calcutta	4,05,242
6.	Chittagong	1,53,610
7.	Delhi	2,41,988
8.	Gaya	3,07,369
9.	Hyderabad	51,071
10.	Jodhpur	1,55,500
11.	Karachi	5,54,243
12.	Lahore	73,708
13.	Madras	1,69,068
14.	Poona (Meteorological)	38,516
	Total ..	31,12,431

Note.—The figures include the total cost of joint stations used for marine and other services in addition to Aviation.

This property is vested in the Posts and Telegraphs Department but the P. & T. Department is indemnified against any capital loss due to cessation of use of buildings and equipments, etc., provided for aviation.

2. (*i*) The aeronautical radio organisation consists of 7 communication and direction finding stations on the Trans-India route; 5 on the South India route; one on the North West India route; one short-wave communication station for meteorological service at Poona; and 3 Air Ministry stations on the Trans-India seaplane route.

(*ii*). A standard aeronautical radio station in India, when fully equipped, consists of one Medium Frequency communication channel for aircraft and point to point communication; one High Frequency channel mainly for point to point communication but available for aircraft communication; one Medium Frequency Adcock, Direction finding station. A second Medium Frequency channel is being installed at Karachi.

(*iii*). On the Trans-India route there are 6 stations fully equipped with Medium Frequency and High Frequency communication and Adcock D F and one station with Medium Frequency communication and Bellini-Tosi D. F. only. On the South India route there are five Medium Frequency communication stations of which two were equipped with Adcock D/F and three with Bellini-Tosi. In addition to these, there are two private Medium Frequency point to point and aircraft stations at subsidiary aerodromes operated by an air transport company (Tata Air Lines). On the Trans-India seaplane route there are two fully equipped Medium and High Frequency communication stations with Adcock D. F. and one temporary station comprising Medium Frequency communication and Bellini-Tosi D. F.

(*iv*) Of the Government of India stations, three on the trans-India route and three on the South India route were provided expressly for aviation. Two on the trans-India route were converted for aviation purposes (*i.e.*, Delhi and Allahabad). Two on the trans-India route and two on the South India route (*i.e.*, Karachi, Calcutta, Bombay and Madras) were converted to joint service stations, aviation facilities being added to marine and, to a lesser extent, general inland communication services for which these stations were originally designed. These converted stations are mainly located in defended areas in positions which would not have been chosen for aeronautical purposes. The six stations provided expressly for the aviation service were sited for this purpose only.

SECTION II—POST-WAR RADIO SYSTEMS.

3. Services under the following heads require consideration:

Short and long range two-way communication (Air to ground, ground to air, point to point—meteorological, operational, traffic and administrative).

Short and long-range aids to navigation.

Aids to final approach and landing.

Airway control.

Airport local control.

Collision warning.

Aids to rescue operations.

These heads are discussed, item by item, in the following paragraphs:

SHORT AND LONG-RANGE TWO-WAY COMMUNICATIONS.

(*a*) *Aircraft Communication.*

4. By aircraft communication is meant communication from air to ground and *vice versa*. The first change which we have to take into account is the trend towards H. F. and V. H. F. communications. The greater range with lower power and less expensive apparatus, which factors are important on the ground, are of overriding importance in aircraft. American civil transport aircraft before the war were not fitted with medium frequency transmission apparatus and used intermediate and High Frequency for communication. The Commonwealth Radio Conference relegates Medium Frequency communication to regions where special difficulty is experienced with H. F. propagation. India is not one of these. The same arguments apply on the internal routes of India. H. F. will be the standard system for medium and long range communication with aircraft. H. F. communication is required for distances greater than V. H. F. range. High Frequencies provide the only practical means of two-way communication with aircraft at long range. The same equipment is capable of providing the necessary service at intermediate ranges and cover at short ranges in the event of failure of the V. H. F. communication set. Communication with Flight Control by radio telephony is a basic saftey requirement, and V.H.F. equipment can be used with greater reliability and in smaller aircraft than other types. V.H.F. communication is free from static and adjacent station interference though limited approximately to optical range. Current American civil aeronautical radio practice as well as R. A. F. practice is based upon V.H.F. communication for airport control. Both H. F. and V. H. F. aircraft equipment is in large scale production in the U. K. and the U. S. A. for military use. The establishment of the H. F. and V. H. F. communication systems will result in the existing M. F. communication stations going out of use and no new M. F. stations will be established.

5. **V.H.F. communication stations.**—The services provided are—

(*i*) Personal telephonic communication between control and pilots when languages permit;

(*ii*) Telegraphic communication between control and aircraft when languages do not allow telephone working;

(*iii*) Other telephonic and telegraphic communication between ground and aircraft up to a range of 75/125 miles at 3,000/9,000 ft. respectively.

The corresponding V. H. F. set in an aircraft provides in addition :

(*iv*) Short range aid to navigation in conjunction with V. H. F. D/F. stations ; and

(*v*) Aid to final approach and landing in conjunction with ground Radar Scanning systems.

Two principal types of V. H. F. communication stations are likely to be required.

(*i*) Airport stations for airport control purposes at short ranges up to about 30/50 miles. Power output 2 to 10 watts.

(*ii*) Airway stations for airway control and communication up to about 125 miles (the limit of optical range at approximately 9,000 ft.). Power output 30 to 100 watts.

6. **H. F. communication stations.**—The services provided are—

(*i*) Long range telegraphic communication ;

(*ii*) Telegraphic and telephonic communication at intermediate ranges down to the maximum V. H. F. range, and

(*iii*) Standby telegraphic or telephonic communication with aircraft in which the V. H. F. communication set has failed.

The corresponding H. F. communication set in aircraft provides in addition long range aid to navigation in conjunction with H. F. D/F stations.

Two principal types of H. F. communication stations are likely to be required :

(*i*) Long range high power stations.

(*ii*) Medium range station, at certain international airports and elsewhere on a limited scale to provide a standby airport control communication service in case of failure of an aircraft V. H. F. communication set.

(*b*) *Point to Point Communication*

7. (*i*) The safety of aircraft and the efficient operation of air transport necessitates high speed communication of a large number of traffic messages along the route. The problem of passing required information, from aerodrome to aerodrome, both short distance and long distance, requires careful consideration. Experience has shown that the number of channels required to maintain adequate communication is very large. Morse radio links, working a number of adjacent stations, have proved most unsatisfactory, and even in cases where a special radio link has been allotted between two aerodromes, the problem of allocating suitable frequencies and other technical restrictions have shown that it is not always capable of handling the messages required with the requisite speed. Morse transmission is restricted to about 18 to 20 W. P. M.

(*ii*) **Teleprinter circuits.**—Point to point radio communication has ceased to be employed in the U. K., the U. S. A. and other progressive countries, and is kept for working with mobile W/T stations and as a standby in case of a breakdown of normal landline communication. The use of the teleprinter has been fully exploited there, and future development of aeronautical point to point communication in India should also follow this line. This also applies to the meteorological services, which have furnished more than half of the point to point traffic in the past. The speed of the teleprinter is about 40 W. P. M. and its superiority in the matter of speed over the normal morse radio circuit is noteworthy. One teleprinter channel being equal to two radio channels, one typist is capable of replacing two morse radio operators. It has been necessary, in the past, to restrict the number of messages

passed between aerodromes because of the limitation of the radio communication, and these restrictions have often been a severe handicap in the working of the aeronautical services. At the end of 1941 the Federal Airways System of the U. S. A. had 453 weather reporting airway and airport stations and 139 traffic control stations equipped with teletypewriter service. There were 55,268 miles of weather reporting teletypewriter service and 12,621 miles of traffic control teletypewriter lines. The future development of aeronautical point to point communication must be based on the utilisation to the fullest extent of teleprinter circuits.

8. **Radio circuits.**—As a standby in case of storm or other disturbances, which occasionally interrupt landline communication, it is proposed to maintain one short distance point to point radio channel between stations, supplemented by a long distance channel between important stations. These will serve not only internal requirements, but also will maintain communication with stations outside India. In the U. K. all telecommunication lines are underground cables working only over short distances. The problem in India with its long overhead landlines and their exposure to heavy tropical weather conditions, make it essential that there should be a standby in case of a breakdown of the teleprinter circuits, even of short duration. Complete duplication of the organisation to meet all point to point traffic requirements, both by radio and teleprinter, is not justified, but it is essential that there should be provision of communication by radio to handle the more important messages in case of the breakdown of the normal teleprinter (landline) circuits. At the end of the war and pending the installations of these teleprinter circuits, it is proposed to utilise to the fullest extent the radio links that have been installed throughout India by the R. A. F. for transport and reinforcement purposes and for the meteorological war requirements. It is thought that those available will be adequate to meet the immediate civil requirements and that they will survive long enough to enable the teleprinter scheme to be implemented. Arrangements with the Air Forces in India will be necessary whereby the service will be provided by the Air Force stations during the transition period until the stations are taken over or civil stations provided, as the case may be. In certain special cases it will be necessary to retain radio links for the whole traffic because teleprinter landline communication will not be available, *e.g.*, Karachi/Jiwani.

9. **Local communication.**—The communication system must be completed by teleprinter circuits connecting separated units of a local organisation such as the aerodrome control and meteorological office, when the latter is not situated in the administrative buildings on the aerodrome. These circuits are much simpler and there should be no difficulty in installing them immediately after the war.

10. Summing up, the communication systems required after the war will consist of—

(*i*) V. H. F. W/T and R/T aircraft channels for airport and airway control.

(*ii*) H. F. W/T and R/T aircraft channels for airway control.

(*iii*) Inter-aerodrome teleprinter circuits for operational, traffic and administrative messages.

(*iv*) Inter-aerodrome teleprinter circuits for meteorolgical messages.

(*v*) Local teleprinter and telephone circuits connecting scattered units at certain aerodromes.

(*vi*) Medium distance standby point to point traffic H. F. W/T channels.

(*vii*) Long distance point to point H. F. W/T channels.

(*viii*) Supplementary H. F. W/T channels for inter-station working for operational, traffic, administrative and meteorological messages to the extent that teleprinters cannot be provided.

Short and Long Range Aids to Navigation

11. The systems available under the above head are :—

(*i*) M. F. D/F.

(*ii*) H. F. D/F.

(*iii*) V. H. D/F.

(*iv*) M. F. "Radio Ranges" or track guides.

(*v*) M. F. Beacons.

(*vi*) V. H. F. Navigational Radar Beacons.

12. In broad outline the problem remains the same as it always was, *i.e.*, a choice between three systems. It is the apparatus which has been developed for each of those systems which varies the problem and the weightage to be given to the factors on which conclusions are based. The three systems are :—

(*i*) Direction and/or position finding on the ground and communication of the result by radio to the aircraft. The current systems are M. F. , H. F. and V. H. F. ground D/F.

(*ii*) Direction and/or position finding in the aircraft with the aid of beacons (which may be of special type) on the ground. The systems available are M. F. beacons, V. H. F. navigational Radar beacons and special Radar Grid stations. The last system is still secret and will not be considered further.

(*iii*) Directional transmission from the ground whereby the pilot follows a fixed route indicated by radio, *e.g.*, "Radio Ranges".

13. **M.F. D/F Stations.**—The system is well known in India, being the only navigational aid for aircraft so far provided for civil aircraft. The associated M. F. transmitters have also been used for the transmission of homing signals. The recommendation of the C. E. R. C. A. is that M. F. D/F stations should be retained where already installed but new installations are not recommended in view of alternatives which are and will be available. M. F. communication and direction finding were widely used before the war at normal telegraphic ranges up to 400 miles. The basic technique is well known and need not be described further. In the ultimate post-war period the use of M. F. is relegated to regions where H. F. communication is unsatisfactory. It is expected, however, that for the first five years after the war there will be aircraft fitted with M. F. transmission apparatus. The use of M.F. D/F will therefore be continued where stations exist in order to extract the maximum benefit therefrom. Other places will be dealt with by different systems.

14. **H.F. D/F Stations.**—For long range aid to navigation, (*i.e.*, at ranges beyond the range of M. F. D/F such as may be involved in the international routes) H. F. D/F is the only system immediately available. A possible alternative for this purpose in the ultimate post-war period is a specialised ground H. F. Radar Grid system. H. F. D/F by selection of suitable frequencies, will also provide D/F service at medium and short ranges which would otherwise be covered by M. F. D/F. In adopting the H. F. D/F system instead of expanding the M. F. D/F organisation, the factors are: (1) lower cost, (2) availability of equipment, (3) the gradual elimination of M. F. aircraft equipment and (4) the permanent need for long range aids to navigation.

H.F. D/F Stations provide the following services :—

(*i*) Long range aid to navigation.

(*ii*) Medium and short range aid to navigation (in place of M. F. D/F).

(*iii*) Aid to airway control and distress organization.

The technique of the "Spinning Radio-Goniometer" or its electronic equivalent proposed. This has been fully developed during the war for special services and has

the following important advantages F. H. over D/F techniques previously in use for aeronautical services.

(*i*) Multi-channel working can easily be provided from a single aerial system.

(*ii*) Remote indications with multi-channel and full operating facilities can be provided up to about two or three miles distance by transmission over low loss cable. Remote indication is also readily possible up to about 20 miles over telephone circuits by the use of two cable pairs for each channel required and by the use of special remotely controlled receivers at the D. F. sites.

(*iii*) Signals can be read simultaneously with the taking of bearings which are indicated on a horizontal scale on a Cathode-ray tube. The indications on the tube can be read by several people simultaneously or repeater tubes can be installed in different parts of the same building.

During the war considerable advances have been made in the reduction of polarization errors and these improvements will be incorporated in post-war H. F. D/F stations for Civil Aviation.

15. **V.H.F. D/F Stations.**—The recommendation of C.E.R.C.A. is "initially these facilities should be installed at main airports". These stations provide the following services :—

(*i*) Navigational aid to small aircraft equipped only with the V. H. F. communication set.

(*ii*) Without carriage of additional airborne equipment a standby navigational aid is provided for larger aircraft in case of the failure of the V.H.F. Radar set.

In practice these services would be provided by embodying D. F. facilities at V.H.F. communication stations. The application of "Spinning Goniometer" technique or its electronic equivalent to V.H.F. D/F has not yet been fully investigated. Initially, manually operated V.H.F. D/F stations will have to be installed.

16. **M.F. Radio ranges or track guides.**—This is a system which has been developed and universally adopted in America and followed in certain other countries. Whatever measure of technical perfection is achieved in the apparatus for this system it loses none of its fundamental characteristics. It marks a route and leads the aircraft to its destination along that line only. Progress along the track is indicated by marker beacons installed along the route. Radio ranges are of no assistance to aircraft flying elsewhere than on these routes. The recommendation of C. E. R. C. A. is "retain where already installed and frequencies available but new installations not recommended". India has none of these installations and no new installations are therefore proposed.

17. **Radar Range.**—The Radar principle has been applied experimentally towards the development of a V. H. F. track guide which might be termed the "Radar Range," This has great possibilities and is likely to find favour internationally. There is continuous indication of range and consequently marker beacons are not needed along the track. The significant property of the "Radar Range", as opposed to the American radio range, is that the same beacon can be used for range fixing by aircraft that are not using track guidance. The "Radar Range" has not yet been developed commercially and is not likely to be available immediately after the war.

18. **M.F. Beacons.**—This consists of a high power M. F. transmitter which is keyed manually or automatically. The same transmitter can also be used for the dissemination of meteorological data. The associated airborne equipment is the radio compass, which enables the aircraft to home on the beacon from any direction from medium distances greater than V.H.F. range. By the application of simple methods of navigation, radio beacons, combined with a radio compass in the aircraft, can be used with advantage even when the beacon is not at the destination of the aircraft. The radio compass can be used in association with any M. F. transmitter, *e.g.*, a broadcasting station, but these transmitters are not always available when they are required. This system of navigation is very popular at the present time and because

of its universal usefulness in regions away from specialised organisation, but where M.F. transmitting stations are at work, it may never be superseded. The Commonwealth Radio Conference considered that additional M. F. beacons may be required in the initial post-war period, but that in the ultimate standardised equipment period, the provision of Radar navigational beacons will remove some of the importance of the M. F. beacon, except in regions where H. F. propagation is unreliable and the M.F. beacon is required as a standby. There is clearly a need to await further indication of the lines of future development before embarking on a special programme of installation of high power M.F. beacons. A beacon service can be provided at a number of places in India by using existing M. F. transmitters, which are gradually going out of use, either in their existing positions or reinstalled in more suitable locations. Such transmitters can continue to serve other purposes, apart from working with the M. F. D/F station, such as weather broadcasts for aircraft and additional standby channels in the event of interruption of the teleprinter channels, though these uses too, may dwindle in importance as other features of the communications system develop. An essential feature of the programme therefore is the development of a M. F. beacon service to the extent that equipment is available pending further developments. If and when the system is ultimately superseded those transmitters which still have a useful life can be disposed of for other than aviation services.

19. **V.H.F. Navigational Radar Beacons.**—By far the most interesting war-time development that will be available to us after the war is V.H.F. navigational Radar Beacons. The great advantage of this system over other radio navigational aids is that continuous indication of range is given and in addition azimuth indication which may be in the nature of an omnidirectional beacon or a track guide beacon.

These stations provide the following services :—

(*i*) Short range aid to navigation.

(*ii*) Omnidirectional airport homing service.

(*iii*) Warning of collision with specially dangerous high ground and exceptional obstructions marked by Radar beacons.

(*iv*) Provision of track guidance where necessary without impairing the services provided under (*i*) and (*ii*).

20. In general two principal types of Radar beacon equipment are likely to be required :—

(*i*) Major beacons sited between 80 and 150 miles apart to provide optimum aid to navigation at the maximum possible optical range.

(*ii*) Minor beacons for use wherever it is necessary to site stations less than 80 miles apart in order to provide additional aid to navigation, *e.g.*, homing beacons at airports.

21. Navigational Radar beacons are coded to indicate their identity. An aircraft within a range more than one beacon can generally fix its position accurately by plotting its range from each beacon. Range accuracy is not impaired by site errors or atmospheric conditions. An aircraft fitted with homing aerials and compass can fix its position approximately from one beacon by plotting range and bearing. It can also home to airport beacons from any direction. Track guidance can be provided where necessary with two or more legs orientated as desired in accordance with normal Radio Range practice. The ground equipment is economical by virtue of its low mean power rating and unattended operation. Stations may therefore be provided at frequent intervals along airways to compensate for the limitations of V. H. F. range. Similarly duplicate ground equipment may be provided without undue expense, one set starting automatically if the other fails. This facilitates maintenance in remote sites.

22. In spite of the potentialities of this system it is not proposed to embark on any big scheme to equip all our air routes with the current type of navigational Radar beacon in the immediate post-war period. The first reason is that navigational

Radar beacons at present in general use can be greatly improved. The Radio Conference found that certain advantages would accrue through the use of higher frequencies bordering on the centimetric wave band, mainly because certain associated equipment with other applications work better on the higher frequencies. Centimetric Radar beacons have already been produced experimentally and have proved satisfactory. The international standardization of Radar beacons working in the centimetric wave band will be considered at the first International Radio Conference. The second reason is the "Radar Range" development described in para 17. As the Radar Range offers definite advantages (which in countries used to the radio range system may be highly rated) over plain Radar beacons without track guidance the decision of the International Radio Conference on this point will also have to be awaited. In the immediate post-war period, however, it is proposed to equip only the four international airports with current types of V.H.F. Radar beacon. This is the recommendation of the C.E.R.C.A. Large numbers of transport aircraft will have by then been fitted with the associated airborne equipment.

Aids to Final Approach and Landing

23. The systems available under this head are—

(*i*) Ground D/F (M.F. H.F. and V.H.F.)

(*ii*) Radio Ranges (M.F. and H.F. and V.H.F.)

(*iii*) Radar Localizers.

(*iv*) Glide path.

Supplementary system for approach and landing which are now most secret may be available for Civil Aviation after the war. None of the equipment proposed under this head will be outmoded if we decide later to adopt these other systems for monitoring purposes or as supplementary aids.

24. **Ground D.F. Systems and Radio Range.**—These have been considered under the head of navigation. Ground D. F. systems are of limited value as an aid to final approach. The principle of the Radio Range, working on H.F., was, long before the war, applied to the guidance of aircraft locally to the landing path. Later, V.H.F. apparatus was developed for the same purpose. Range or distance from the aerodrome is indicated by marker beacons. The system has been extensively used both in civil aviation and during the war. None of these stations was installed for civil aviation in India and the development of the Radar Localiser during the war has made it unnecessary to consider the system further.

25. **Radar Localizers.**—Radar Localizers provide guidance in azimuth and range for final approach. The system utilizes the V.H.F. Radar set which serves also for navigational aid and collision warning. The design of the ground station conforms to normal Radar beacon practice except that coding is not required. A special aerial system produces two narrow over-lapping lobes which define an equisignal track. The station is located at the far end of the runway in use with the equisignal axis along the runway. Continuous indication of range obviates the need for marker beacons with their associated siting difficulties in populous areas and over water. The ground equipment is compact and relatively cheap so that it can without undue expense be installed permanently at the ends of each runway for immediate selection by a switch in the control tower.

The equipment as at present designed will later be superseded by newer installations working in a higher frequency band (see under navigational Radar beacons). Initially it is proposed to equip only the international aerodromes with current types of Radar localizers for use by aircraft fitted with the current type of V.H.F. Radar set. Three of these aerodromes—Karachi, Delhi and Calcutta—are subject to ground fog conditions in the winter, while Bombay and Calcutta are subject to low visibility monsoon conditions, which makes such aids desirable. A supplementary programme for extension of the system to other aerodromes in India where weather conditions necessitate it will be drawn up after agreement on international standardization has been reached.

26. **Glide Path Transmitter.**—The Glide path is the most suitable system of guidance in elevation so far produced. The type of glide path proposed depends upon the production of an equisignal path in the vertical plane at an angle of about 3° to the horizontal plane. During the final approach this transmitter provides guidance in elevation for aircraft using the Radar Localizer for guidance in azimuth. There is already tentative Anglo-American agreement to standardise on 335 Mc/s for military glide path installations. Satisfactory performance can be obtained at this frequency on most sites, from which there would be no object in departing. The U.S. Civil Aeronautics Administration has in hand a programme of 335 Mc/s glide paths. As there would be no point in installing glide paths without the associated runway localizer equipment, it is proposed initially to equip only the international airports with glide path installations. It does not appear at present that weather conditions in India will necessitate much extension.

Airway Control

27. Airway control depends on efficient two-way aircraft and point to point communications. The systems proposed under "communications" will provide this service.

Airport Local Control

28. The primary system is V.H.F. W/T and/or R/T communication. The equipment is inexpensive (power output two to ten watts) and several channels may be needed ultimately if the load on one frequency becomes too great. The first sub-division to be made will be between the airport control frequency and surface traffic control frequency for controlling movement of aircraft and surface vehicles on the ground. Radio telephony will normally be used whenever language permit but provision will be made for telegraphic working. In the event of failure of V.H.F. a stand by service can be provided by H.F. and M.F. communications (the latter where available). There will be supplementary systems available sometime after the war for airport local control but as these systems are still secret they will be considered at the appropriate time. None of the equipment proposed for airport local control in the immediate post-war period will be outmoded with the introduction of these supplementray aids.

Collision Warning

29. The only method immediately available is two-way communication and control from the ground. For the ultimate post-war period, other proposals have been made which involve the carriage of miniature Radar responders in aircraft. The same V.H.F. Radar set carried in aircraft for use with Radar beacons and Localizers will be used for interrogating airborne responders in other aircraft, and thus obtain warning of collision by simple means. By the inclusion of coding, aircraft can be identified to each other and to ground control. This device will not affect the ground organisation, except that it will tend to relieve it of some of the burden. The ground radio stations will probably always be one of the means of control of collision risk, and the special devices referred to in paragraph 28 will be necessary at the busier aerodromes for this purpose. No special organisation under this head is proposed in this programme.

Distress Service

30. Only airborne equipment is involved and consists of (*i*) C. W. Rescue Beacon and (*ii*) Radar Rescue Beacon. For the purpose of this paper, it is unnecessary to deal with the details of the systems proposed as no ground equipment is involved. The communication stations at key points like Karachi and Calcutta will, as in the past, be actively employed in all distress and rescue operations.

SECTION III—EQUIPMENT TO BE PROVIDED

31. The Radio organisation proposed comprises stations at 70 aerodromes of which 50 are to complete the air routes for the international and internal air services

referred to in the post-war transport plan and 20 stations at points not yet determined to serve the local air services which will be initiated in the early post-war period. At least five other stations in neighbouring countries will be needed to complete the trunk routes included in the internal air transport scheme. In addition, it is proposed to equip the Air Service Training School fully with representative W/T equipment of the international airport standard. The object of this is twofold. The station will be used primarily for the training of W/T operators, W/T technicians, aerodrome officers, pilots and aircrews and it will also serve as an experimental station where development work would be carried out and new equipment tested. As new air routes develop more W/T stations will be needed, but the present plan cannot, for sundry reasons, be extended beyond the initial post-war period. A provisional schedule of the radio stations is given in Annexure I. The radio stations have been classified into 4 international, 12 major, 27 intermediate and 27 minor stations plus 1 training and experimental station.

32. International aerodromes are aerodomes at which it is expected world air services will stop and which will be organised to a standard fit for international air transport in addition to internal air services. Major aerodromes are the principal aerodromes at which internal air services will land. Intermediate aerodromes are the more important aerodromes on scheduled routes at which landings will not regularly be made. The intermediate aerodromes include also some of the regular stops on subsidiary routes where traffic for some years will not be of such magnitude as to justify their staffing and equipment as major aerodromes. Minor aerodromes are aerodromes which will be used in emergency by the regular services and which will also be used as refuelling stops by short range aircraft flying over the routes.

33. As previously explained the scope of the present paper is limited. It only covers the immediate post-war period and may extend to five years after the war. For this reason, Radar devices do not find a prominent place in the proposals that follow. After international standardisation has been reached on types of Radar systems to be used for Civil Aviation and the frequencies to be used, and suitable equipment is in production, it will be necessary to prepare a supplementary radio programme for India. For the present, it is proposed to equip only the four international airports and the experimental station at the Air Service Training School with current types of Radar apparatus. The experimental station will be equipped with new types of Radar apparatus as and when it becomes available for experimental development. Besides complying with the recommendation of C.E.R.C.A. the installations at international airports will provide valuable experience in the working and maintenance of Radar devices.

34. The Aeronautical Radio Service will provide such radio communication as may be required by the meteorological service for aviation except where meteorological services are specially provided for the Air Forces, for which radio communication will be the responsibility of the Air Forces. The Director General of Observatories plans to deal with all meteorological point to point traffic, such as exchange of synoptic and other data between meteorological stations, by teleprinter, which conforms with the essential and generally adopted policy of removing from the overloaded radio channels as much as possible of the traffic which can be dealt with effectively by land lines. The teleprinter channels for the meteorological service will be provided by direct arrangements with the Posts & Telegraphs Department. Teleprinter channels for the aviation service only are provided for in these proposals. It is not proposed to provide radio point to point channels to give 100% duplication of the teleprinter channels as a standby. The standby radio point to point channels provided in these proposals will be available for both aviation and meteorological traffic to the extent of their capacity in emergency. This service is mainly confined to the air routes. In the interim period, until teleprinter channels are available, the meteorological point to point traffic must continue to be carried by the R.A.F. W/T network built up for that purpose during the war, supplemented where necessary and suitable by the ordinary land line telegraphs. The meteorological organisation needs radio communication for the exchange of synoptic data with other countries, both near and far. While this is essential for aviation, as it is for other work of the Meteorological Department, it cannot be wholly related to Aviation, and for the sake of

clarity, it is recorded here that the transmitting stations at Poona, at Nagpur and the receiving stations at Calcutta, Karachi, Bombay and Madras required for this purpose are not included in this programme. It is assumed that these radio services will be provided by arrangement with the Posts and Telegraphs Department. If it should prove to be more convenient for these radio services to be provided by the Aeronautical Radio Service, a supplement to this programme will be necessary.

35. It is proposed that the wireless stations in the different categories of aerodromes shall be equipped as follows. The details are tabulated in Annexure II.

(*i*) **International Aerodromes**—4.

(*a*) Inter-aerodrome teleprinter circuits for operational, traffic and administrative messages.

(*b*) Local teleprinter and telephone circuits connecting scattered units at the aerodrome—as and where required.

(*c*) Short-distance stand by H.F. W/T point to point channel. Two frequencies will be required at Karachi, Delhi and Calcutta to avoid interference between Northern and Southern routes.

(*d*) Long-distance H.F. W/T point to point channel for operational traffic and administrative messages.

(*e*) One H.F. W/T point to point channel at Karachi for communication with Jiwani and one at Calcutta for communication with nearby stations in Burma.

(*f*) Long-distance H.F. W/T aircraft channel.

(*g*) Short-distance H.F. W/T aircraft channel (with provision for telephonic working when necessary).

(*h*) V.H.F. R/T (airway frequency) aircraft channel (with provision for telegraphic working when languages do not permit telephonic working).

(*i*) V.H.F. R/T (local airport control frequency) aircraft channel (with provision for telegraphic working when languages do not permit telephonic working).

(*j*) M.F. D/F where existing (working from D.F. station only—not necessary to provide auxiliary M.F. Communication in Control Room).

(*k*) H.F. D/F.

(*l*) V.H.F. D/F.

(*m*) M.F. Beacon.

(*n*) Navigational Radar Beacon.

(*o*) Radar Localiser.

(*p*) Glide Path.

(*ii*) **Major Aerodromes**—12.

(*a*) Inter-aerodrome teleprinter circuits for operational, traffic and administrative messages.

(*b*) Local teleprinter and telephone circuits connecting scattered units at the aerodrome as and where required.

(*c*) Short-distance stand by H.F. W/T point to point channel.

(*d*) H.F. W/T aircraft channel (with provision for telephonic working when necessary).

(*e*) V.H.F. R/T (Airway frequency) aircraft channel.

Note :—This frequency will also be used for local airport control. If the load on the channel becomes too great a separate "local control" channel will have to be provided as at international airports.

(*f*) M.F. D/F where existing (working from D/F station only—not necessary to provide auxiliary M.F. Communication in Control Room).

(*g*) H.F. D/F.

(*h*) V.H.F. D/F.

(*i*) M.F. Beacon—so far as equipment is available.

(*iii*) **Intermediate Aerodromes**—27.

(*a*) Inter-aerodrome teleprinter circuits for operational, traffic and administrative messages.

(*b*) Short-range standby H.F. W/T point to point channel for operational, traffic and administrative messages.

(*c*) H.F. W/T aircraft channel (with provision for telephonic working when necessary).

(*d*) H.F. D/F.

(*iv*) **Minor Aerodromes**—27.

(*a*) H.F. W/T aircraft channel (with provision for telephonic working when necessary) *Note* :—In rare instances when it becomes necessary to communicate with adjacent stations the same (aircraft) channel will be used.

(*b*) H.F. receiver only for simultaneous watch on short-distance point to point frequency.

(*v*) **Air Service Training School Station**—1.

As for an International Airport with the exception of items (*b*), (*d*), (*e*), (*f*), (*h*), (*j*) and (*m*).

36. For the 71 radio stations required for the new organisation (4 International, 12 Major, 27 Intermediate, 27 Minor and 1 Experimental Station at the Air Service Training School) the following buildings and apparatus only are available :—

(*a*) 11 radio communication station buildings (including quarters).

5 Government of India Aeronautical stations. (Jodhpur, Gaya, Chittagong, Ahmedabad, Hyderabad, Bangalore).

3 Government of India Converted stations (Delhi, Allahabad, Lahore). Buildings not usable after M. F. service ceases.

2 Air Ministry stations (Jiwani and Gwalior). Jiwani could be made use of by arrangement with the Air Ministry.

(*b*) 9 D/F station buildings (including quarters).

7 Government of India stations (Jodhpur, Delhi, Allahabad, Gaya, Calcutta, Ahmedabad, Bangalore).

2 Air Ministry stations (Jiwani, Gwalior). Jiwani could be made use of by arrangement with the Air Ministry.

(*c*) 9 Adcock D/F receivers [*vide* (*b*) above].

7 Government of India stations. (Jodhpur, Delhi, Allahabad, Gaya, Calcutta, Ahmedabad and Bombay).

2 Air Ministry stations (Jiwani, Gwalior)—can be made use of by arrangement with the Air Ministry.

N.B.—The Bombay installation is a twin channel type which means that the D/F receiver alone is available and not the masts or the feeder systems.

(*d*) 12 H. F. transmitters and receivers.

9 Government of India stations. (Karachi, Jodhpur, Delhi, Allahabad, Gaya, Calcutta, Bombay, Bangalore, Madras).

3 Air Ministry stations (Jiwani, Gwalior, Raj Samand). Apparatus could be taken over subject to Air Ministry agreement.

(*e*) 16 M. F. transmitters.

13 Government of India stations (Karachi, Jodhpur, Delhi, Allahabad, Gaya, Calcutta, Chittagong, Bombay, Ahmedabad, Hyderabad, Bangalore Madras and Lahore).

3 Air Ministry stations (Jiwani, Gwalior, Raj Samand)—can be made use of by arrangement with the Air Ministry.

(*f*) 6 M. B. T. D/F receivers.

5 Government of India stations. (Chittagong, Madras, Hyderabad, Bangalore and Lahore).

1 Air Ministry station (Raja Samand)—can be made use of by arrangement with the Air Ministry.

(*g*) The following apparatus is on order for new works and will also be available for the new organisation :—

Medium Wave transmitters	3
Short Wave transmitters	3
Medium Wave receivers	3
Short Wave receivers	4
Adcock receivers	6

The extent of additional associated buildings and plant which will be available depends on the settlement of a current programme of installation for Air Force or Civil Aviation needs, not yet settled.

37. The remaining buildings (including quarters for personnel) and apparatus have to be provided. Buildings have been provided for, on a broad estimation basis, in the Works Programme. It is probable that some of the apparatus will be available to be taken over form the Air Forces. The extent to which this will help to meet the equipment problem cannot yet be indicated or even investigated very far. In more rare cases there may be buildings of suitable type and in suitable locations to be taken over from the Air Forces. Generally speaking the majority of the new stations will have to be newly sited. In view of the above, the re-organisation proposed is far less a matter of taking over an organisation from the P. & T. Department, than building up a completely new organisation. Both the P. & T. and the Air Force radio organisations will have to continue to provide the radio service where they are established during the gradual process of building up and taking over.

SECTION IV—ESTIMATES OF COST (MATERIAL)

38. In present conditions it is almost impossible to get data on which to base a close estimate of the cost of a programme of this magnitude. It can, therefore, only be attempted on a broad basis using such data as can be deduced from pre-war costs of apparatus and installations. In Annexure III an estimate of this character is given for the capital cost of apparatus and installation and the recurring cost of maintenance (Material only—personnel and labour will be dealt with separately in Part II). Radio station buildings, quarters for personal and power supply have been provided for separately in the Aerodrome and Air Routes Construction programme, but some addition will be necessary, for this Radio programme is considerably bigger than could be foreseen at the time the Works Programme was prepared. The Works Programme includes Rs. 13 lakhs for technical buildings for 46 stations and the number of stations has been increased to 71. Quarters for wireless staff have been included, on a 50% basis on a broad estimate of total Aviation and other staff to be provided for and the estimated number of wireless staff has increased largely. At this stage of broad estimation, it is unnecessary to do more than to note that the Works Programme will need some adjustment.

The capital cost of the equipment is estimated at Rs. 41 lakhs, and the cost of installations at Rs. 13¼ lakhs. This is based on new equipment and installation, except in the case of M. F. D/F stations and M. F. Beacons on which no new capital expenditure is proposed. If, as seems likely, a quantity of suitable equipment is available from R.A.F. sources at disposal prices, and when allowance is made for some of the existing P. & T. apparatus being used as indicated in Section III, there will be a saving in capital cost of equipment. Economy will also be possible in the capital

cost of installation, as some of the equipment will be available already installed at site, either in existing P. & T. stations or in Air Force stations. In view of the lack of precise data regarding costs the capital cost estimate should stand.

The annual recurring cost of maintenance and operation of the radio stations (excluding personnel and labour) is estimated at Rs. 5.4 lakhs. In view of past experience and the expected rate of future development, it would be wise to treat the whole of the apparatus on very much the same basis as aircraft are treated and to write it off by an obsolescence factor, rather than depreciation, over a period of 8 years. The annual cost of the radio service on the material side will, therefore amount to Rs. 12.2 lakhs. To this must be added the cost of the Teleprinter service which will be payable to the Posts & Telegraphs Department which is estimated at Rs. 4.8 lakhs, making a total annual recurring cost of Rs. 17·0 lakhs or a total actual annual expenditure of Rs. 10.2 lakhs.

SECTION V—ORGANISATION OF THE POST-WAR RADIO SERVICE

39. **Principles of Re-organisation.**—The aeronautical radio service is a specialised service and demands the wholetime attention of the personnel engaged in it from the officers in charge down to the operators and mechanics. The officers directing it cannot give it the attention it needs if they have to devote the major portion of their time to telegraphs and telephones and other problems of the Posts and Telegraphs Department. The engineering staff can neither construct nor maintain the stations when their major occupation is the development and maintenance of the telegraph and telephone systems of the country and they are liable to be completely occupied in repairing telegraph lines swept away by flood and cyclone. The operators must be specially selected and trained and must make the Aeronautical Radio Service their career. Only exceptionally, in fact, could men of the calibre recruited as operators in the telegraph service hope to become efficient in the aeronautical radio service. The amalgamation of the old P. & T. Wireless service with the Telegraph service which was effected a few years before the war, was from the Aviation point of view a retrograde step. In the post-war organisation, certain principles are put forward as *sine qua non*. In enunciating these principles, it is proper to record that Civil Aviation has had the greatest help from successive officers of the Posts and Telegraphs Department, who were responsible for the establishment, administration and operation of the aeronautical radio service, and without the aid of that Department in past years, nothing could have been achieved. The organisation has been outgrown and the future demands the application of new principles:—

(*i*) The aeronautical radio service must be a separate service and must be answerable to the Director of Civil Aviation.

(*ii*) To put the organisation on a standard of efficiency comparable with other countries and acceptable to operators of world air services and to the International Authority, and to keep pace with modern development, the service must be put in charge of a first class man with up to date knowledge and experience of aeronautical radio developments. He will have to be supported by a nucleus of officers similarly qualified.

(*iii*) The pay offered to operators, mechanics and other technical personnel must be adequate to attract men of education, intelligence and quick reaction, capable of maintaining the high quality of work which is demanded, and a proportion capable of rising to the higher responsible positions.

No principle is more important than the third of these. The safety of aircraft frequently depends on the skill and quick intelligence of the wireless operator on the ground, who is the link between the Aircraft and the Control staff. The importance of securing this safety factor in the air may be measured by the pay of the crew put in charge of the aircraft. This may amount to anything between Rs. 2,000 and Rs. 5,000 a month and the pay of the aircraft radio operator may vary from Rs. 250 to Rs. 1,000 a month. Holding the other end of this safety line up to date has been a man whose skill and quick intelligence were rated at Rs. 60 a month. This cannot continue.

40. **Direction of the Service.**—The organisation of the Civil Aviation Directorate will be dealt with elsewhere. Here the object is only to show the setting of the Aeronautical Radio Service. The Director will have to be assisted at headquarters by at least two experienced and qualified technical men, one a radio engineer and the other a man with experience in the operation of aeronautical radio. Each will have the assistance of one or two technical asistant. The administrative duties at headquarters will fall into parts, somewhat as follows:—

Communications (Eng.).	*Communications (Ops.).*
1. Research and Development	3. Organisation and supervision of operations.
	4. International Conventions; foreign liaison with P. & T. Department and Air Headquarters.
	5. Personnel—operation and engineering (recruitment, training, posting, etc.).
2. Construction and Maintenance	6. Licensing of air radio operators, aircraft radio stations and companies' ground readio stations, in liaison with the P. & T. Department.

41. **Outstation Organisation.**—The organisation outside Headquarters will consist of 70 Radio Stations, divided into 6 Regions under Regional Radio Controllers, an Experimental and Development Establishment and Workshop and a Training School. The two latter parts of the organisation will be dealt with first.

42. **Experimental and Development Establishment and Workshop.**—(*i*) In a service whose technical development is in such a transmutable state as the aeronautical radio service, it is essential to make practical trial of new types of apparatus, to carry out experimental work generally for the improvement or modification of apparatus and for the elimination of defects, and to do such research work as may be found desirable. Associated with the above works there must be a central project planning and workshop organisation with expert staff for the planning and control of construction and reconstruction work, for carrying out heavy duty, and special repairs, frequency measurements, calibration of D/F stations and technical inspection of all stations.

(*ii*) Provisionally, the organisation will be divided into the following departments:—

(*a*) Workshop.
(*b*) Experimental and Development Section.
(*c*) Project Planning Section.
(*d*) Calibration and Inspection Section (four Calibration parties).
(*e*) Testing Section.
(*f*) Drawing Office.
(*g*) Office.

These functions should be combined under a Research and Development Engineer.

(*iii*) The combined Experimental and Development Establishment and workshop should be located near Headquarters, that is, in Delhi, so that a great deal of the technical work which would otherwise fall to be dealt with by the Headquarters Staff can be delegated to this Establishment, (*e.g.*, project planning).

(*iv*) *Staff.*—The staffing of each section of the Experimental and Development Establishment should be as follows:—

(*1*) *Workshop:*

Staff.	Grade.
1 Workshop Superintendent ..	.. Regional Radio Engineer.
1 Asst. Workshop Supdt. ..	.. Station Engineer.
4 Foremen ..	.. Radio Mechanic.
4 Mistries ..	.. Mistry.

(In addition work-charged establishment will be employed).

(2) *Experimental Section.*

Staff.		Grade.
1 Engineer-in-Charge	.. ..	Regional Radio Engineer.
4 Radio Operators	.. ..	1st Class Operator.
1 Mechanic	.. ..	Radio Mechanic.

(*Note.*—The Experimental Section will employ the other sections of the Establishment as its work requires, *e.g.*, Drawing Office, Workshop and Testing Section).

(3) *Project Planning Section.*

Staff		Grade.
1 Project Engineer	.. ..	Regional Radio Engineer.
2 Asst. Project Engineers	.. ..	Station Engineer.

(4) *Calibration and Inspection Section.*

1 Engineer-in-Charge	.. ..	Regional Radio Engineer.
4 Calibrators and Inspectors	.. ..	Station Engineer.
4 Radio Operators	.. ..	1st Class Operator.
2 Mechanics	.. ..	Radio Mechanic.
4 Motor Drivers } for 4 calibration		..
4 Cleaners } vans.		..

(This section will be responsible for installation and will have to be reinforced from other sections or from outside when large programmes of installation work are on hand. Work charged establishment will be employed).

(5) *Testing Section.*

1 Engineer-in-charge	.. ..	Station Engineer.
1 Radio Operator	.. ..	1st Class Operator.
2 Mechanics	.. ..	Radio Mechanic.

(6) *Drawing Office.*

1 Senior Draftsman }	.. ..	To be assimilated with other Drawing Office Staff in the Directorate.
2 Draftsmen }	.. ..	
2 Tracers }	.. ..	

(7) *Office.*

1 Head Clerk	.. ..
1 Accountant, 2 Stenographers	.. ..
12 Clerks	.. ..
Inferior Staff	.. ..

(c) *Equipment.*—Provision must be made for the equipment of the Workshop, the Testing Section and the Calibration Section with tools, instruments and other equipment. Apart from ordinary equipment, furniture, etc., the following are among the things required :—

(1) Hand tools.

(2) Small machine tools.

(3) Testing and Calibration Instruments.

(4) Motor vans for Calibration.

(5) Survey instruments for Project Engineer.

A capital sum of Rs. 5 lakhs has been provided for this purpose.

43. **Training School.**—It is the express wish of Government that in any scheme of post-war re-organisation and development, there shall be provided full facilities for the training of Indian personnel for the technical services. This is not only desirable in principle, but a hard practical necessity. Training arrangements are required, not only for the staffing of the Government aeronautical radio service, but for the provision of radio personnel for the operating companies. These training facilities can conveniently and economically be combined in one institution and it is contemplated that this radio training will form one department of the Civil Air Service Training School organised to produce air crews, mechanics and other technical personnel for general employment in air transport, as well as the training of aerodrome technical staff. The organisation of this training institute has been dealt

with in another paper on 'Training and Education'. For the present purpose, it is sufficient to say that training will be provided for :—

(*a*) Radio operators for the manning of the Government aeronautica radio stations.

(*b*) Radio mechanics for the Government aeronautical radio service.

(*c*) A limited number of Science or Engineering Graduates for the higher technical posts, with curtailed experience in the lower ranks.

(*d*) Radio operators and engineers for the aircraft operating organisation.

44. **Regional Organisation.**—(*i*) The regional headquarters, which will be responsible for the administration, construction and maintenance and control of operations of the 70 radio stations detailed in Part I will be located at Karachi, Delhi, Calcutta, Bombay, Madras and Nagpur. The regional headquarters will undertake such administration, construction and maintenance duties in connection with the experimental station and the training school as may be found convenient. The division of the radio stations between the Regions is set out in Annexure IV. The staff proposed at regional headquarters and at each type of radio station is shown in Annexure V. The total staff for the completed organisation is estimated at 2,943, including inferior servants.

(*ii*) Each Region will be placed in the charge of a Regional Radio Controller, who will usually be a fully qualified radio engineer, but who must also have the general knowledge and administrative ability required to control operations and administer his region. On the operational side he will have the assistance of a Regional Radio Officer (Traffic), whose duty will be to supervise the operation of all stations in his region and to investigate failures and complaints. He will have to travel frequently to the radio stations in his charge, check operators' work and generally maintain the standard of operations at the highest point of efficiency. Normally, Regional Radio Officers will graduate from the ranks of the operators, supervisors and Radio Officers in charge of stations. On the engineering side, the Regional Controller will be supported by two Regional Radio Engineers. With a staff of radio mechanics they will be responsible for all construction and maintenance in the Region, including the work of station engineers and radio mechanics attached to particular stations. They will be responsible for stores.

45. **Radio Station Organisation.**—(*i*)The staff for each type of station varies with the complexity of the equipment installed, the volume of traffic to be handled and the hours of watch to be maintained. There will be individual variations but, for the present, all radio stations of the same type may be regarded as needing equal staff. The classification of radio stations follows that adopted for aerodromes, and this is broadly related to the volume of air traffic and to the size and complexity of equipment to be dealt with. The allocation of radio personnel to the stations is shown in Annexure V. Provision has been made for 24 hours watch at all stations, a state of development which will only be gradually approached.

(*ii*) International and major radio stations will be under the charge of Radio Officers. After careful consideration of probable future development, it appears that the most important function of the officer in charge of an aeronautical radio station is to supervise the operation and ensure that it never flags from the highest point of efficiency. This will be his constant pre-occupation, whereas the engineering problems of maintenance, repair and development need only intermittently engage his attention. It has therefore been decided to reverse the present practice of the P. & T. Department and instead of putting an engineer in charge of the station, the Radio Officer in charge will be primarily an operations man.

(*iii*) The balance on the engineering side has to be restored. In the station, this will be done by the Station Engineer who will be subordinate to the Radio-Officer, but whose work will come under the supervision of the Reginal Radio Engineers. In the Regional headquarters the position is reversed. The emphasis is on the engineering problems. The Regional Controller is primarily an engineer, and he will have two Regional Engineers, but only one Regional Radio Officer

(Traffic). This principle of centralising engineering (in regions) but devolving responsibility for operations (the hour to our problem) to a greater degree to stations is the basis of the staff planning.

(*iv*) At international and major stations, the Radio Officer in charge will have the assistance on the traffic side of two or more Supervisors, so that at all active periods of operation there will be someone on duty in charge of all operations. Intermediate stations will be under the charge of Supervisors who will then become responsible for ordinary maintenance and minor repairs, through the medium of the Station Engineer and/or mechanics attached to them. Supervisors in charge of stations will be selected from the senior or best qualified Supervisors, and may receive a charge allowance.

(*v*) Radio operators will be classified as 1st Class and 2nd Calss. While a certain minimum service as 2nd Class operator will be an essential qualification, promotion will be based on efficiency tested both by examination and actual work. Provision has been made for about 20% of the total operator strength to be graded as 1st Class. This will provide for the distribution of 1st Class operators to different units and watches at international and major stations, to different watches at intermediate stations and to be posted in charge of minor stations where they will receive a charge allowance. A similar principle will apply to the grading and posting of Radio Mechanics 1st and 2nd Class.

(*vi*) Teleprinter operators are expert typists and are provided in numbers sufficient to maintain teleprinter channels throughout the 24 hours. Until those channels are available, additional radio channels will have to be maintained, and the number of radio operators will be increased but probably not above the ultimate numbers provided. Teleprinter operators will have the opportunity, if they are sufficiently enterprising in their own time, to qualify as radio operators, and all such endeavours will be encouraged and assisted, but there is no natural line of promotion from one grade to the other. The remaining grades of staff need no special explanation.

46. **Estimates of Cost.**—(i) When the full rganistion is attained, the annual recurring cost of staff will amount to approximately Rs. 61.6 lakhs per annum.

(*ii*) Outside the head office, the key posts are those of Research and Development Engineer and Regional Controllers, on whom will largely depend the development of the service to the standard required in iternational aviation both in operation and engineering. The posts might be compared in responsibility with those of Director of Telegraph Engineering in the P. & T. Department or Superintending Engineer in the Public Works Departments.

(*iii*) Regional Engineers, Regional Radio Officers (Traffic), Workshop Superintendent, Engineer in charge Calibration and inspection and Project Engineer are grouped together. The Regional Radio Officer, acting on behalf of the regional Controller, will be the direct link, so far as the operation of the radio service is concerned, with the Regional Aerodrome Officer who in turn is responsible for the co-ordination of all safety services for aircraft in his Region.

(*iv*) For the Radio Officer who will be placed in charge of the important stations, and who will be responsible for both operation and maintenance, the rete of pay proposed is comparable with that proposed for Aerodrome Officer, Grade II, or with Assistant Engineers who are placed in charge of large stations in the P. & T. Department.

(*v*) Supervisors who assist the Radio Officer in supervision of operations and Station Engineers who are responsible to the Radio Officer for the maintenance and ordinary repairs as well as the Assistant Workshop Superintendent, Assistant Project Engineer, Calibrators and Inspectors and Engineer in charge Grade, II are placed on a scale of pay equivalent to the existing Assistant Aerodrome Officer scale but they will not be gazetted.

(*vi*) The scales proposed for Radio Operators and Mechanics are Rs. 150 to Rs. 300 and Rs. 125—250 respectively in place of the P. & T. scale for operators of

Rs. 60 to Rs. 150. The reasons are given above. The difference is not as great as appears since, to conform with the conditions of service of other Civil Aviation staff, free quarters or house rent allowance will not be given. The house rent allowance was equivalent to an addition to the P. & T. scale varying from Rs. 15 to Rs. 60, according to location, serivce and family responsibilities.

SECTION VI SUMMARY OF COSTS

47. Combining the estimates of Part I and Part II, the estimated cost of the Aeronautical Radio Service when developed to the stage provided for in Part I is set out below :—

		Capital Rs. (lakhs)	*Recurring* Rs. (lakhs)
1.	Radio equipment and installation	54.4	..
2.	Maintenance, operation and repairs (Material and Services)	..	5.4
3.	Teleprinter services	..	4.8
4.	Experimental & Development Establishment—Equipment ..	5.0	..
5.	Staff—Operting and Maintenance (excluding Direction) ..	..	61.6
		59.4	71.8
		Say *Rs.* 60 *lakhs.*	Say *Rs.* 72 *lakhs.*

Note :—In addition to this figure of Rs. 60 lakhs must be added a proportion of the P. & T. capital expenditure on buildings and equipment, representing that part which is taken over by or ultimately debited to Civil Aviation.

	Capital costs provided in Works Programme. Rs. (lakhs.)	*Indirect Recurring Cost.* Rs. (lakhs).
Radio station buildings	13.0	Annual provison for obsolescence of equipment. 6.8
Proportion of cost of quarters for Aviation staff not yet allocated between different services. (Rs. 2.28 crores).		

PART 5. ANNEXURE I

Radio Stations Proposed in Post-War Organisation

	Probable scheduled aerodromes.	*Radio Stations.*	*Class.*
Route I—			
Karachi	Karachi	Karachi	International
Colombo	Bombay	Bhuj	Minor
	Madras	Jamnagar	Intermediate
	Colombo	Bombay	International
		Poona	Major
		Guntakal (or Bellary)	Intermediate
		Madras	Major
		Trichinopoly	Intermediate
		Ramnad	Minor
		Colombo	..
Route II—			
Calcutta	Calcutta	Calcutta	International
Kabul	Allahabad	Asansol	Intermediate
	Cawnpore	Gaya	Intermediate
	Delhi	Allahabad	Major
	Lahore	Cawnpore	Major
	Peshawar	Delhi	International
	Kabul	Lahore	Major
		Peshawar	Major
		Kabul	..

PART 5.—ANNEXURE I—*contd.*

	Probable scheduled aerodromes.	*Radio Stations.*	*Class.*
Route III—			
Jiwani	Karachi	Jiwani	Intermediate
Karachi	Jodhpur	*Karachi	International
Delhi	Delhi	Hyderabad-Sind	Minor
		Uterlai	Minor
		Jodhpur	Major
		Sikar	Minor
		*Delhi	International
Route IV—			
Bombay	Bombay	*Bombay	International
Calcutta	Nagpur	Aurangabad	Intermediate
	Calcutta	Akola	Minor
		Nagpur	Major
		Raipur	Intermediate
		Jharsuguda	Intermediate
		Jamshedpur	Intermediate
		*Calcutta	International
Route V—			
Calcutta	Calcutta	*Calcutta	International
Colombo	Cuttack	Amarda Road	Minor
	Vizagapatam	Cuttack	Intermediate
	Bezwada	Berhampur	Minor
	Madras	Vizagapatam	Major
	Trichinopoly	Bezwada	Intermediate
	Colombo	*Madras	Major
		*Trichinopoly	Intermediate
		*Ramnad	Minor
		Colombo	..
Route VI—			
Delhi	Delhi	*Delhi	International
Madras	Gwalior	Gwalior	Intermediate
	Nagpur	Saugor	Minor
	Hyderabad	*Nagpur	Major
	Madras	Hyderabad	Major
		*Madras	Major
Route VII—			
Bombay	Bombay	*Bombay	International
Delhi	Ahmedabad	Surat	Minor
	Delhi	Ahmedabad	Major
		Udaipur	Minor
		Jaipur	Intermediate
		*Delhi	International
Route VIII—			
Calcutta	Calcutta	*Calcutta	International
Rangoon	Chittagong	Chittagong	Intermediate
	Akyab	Akyab	..
	Magwe	Magwe	..
	Rangoon	Rangoon	..

*Indicates repetition of station scheduled higher in the list.

PART 5.—ANNEXURE I—*concld.*

	Probable scheduled aerodromes.	*Radio Stations.*	*Class.*
Route IX—			
Karachi	Karachi	*Karachi	International
Quetta	Quetta	*Hyderabad-Sind	Minor
Lahore	Lahore	Jacobabad	Intermediate
		Quetta	Intermediate
		Multan	Intermediate
		*Lahore	Major
Route X—			
Calcutta	Calcutta	*Calcutta	International
Dinjan	Dacca	Dacca	Intermediate
	Sylhet	Sylhet	Intermediate
	Tezpur		
	Dinjan		
		Tezpur	Minor
		Dinjan	Intermediate
Route XI—			
Madras	Madras	*Madras	Major
Bangalore	Bangalore	Bangalore	Major
Cochin	Cochin	Cochin	Intermediate
Training and Experimental—			
Civil Air Service Training School.	..	Karachi	Special
Local Routes—			
The routes which will come into operation after the war cannot be specified, but the following are examples of the stations likely to be required for local air services soon after the war and for which a reserve of 20 stations is provided.		(Examples only)	
		Lucknow	
		Srinagar	
		Trivandrum	
		Indore	
		Bikaner	5 Intermediate
		Rajkot	15 Minor
		Bhavnagar	
		Baroda	
		Mysore	
		Kolhapur	
		Kalka	

*Indicates repetition of station scheduled higher in the list.

ANALYSIS

Class.	*Number of stations.*
International	4
Major	12
Intermediate	27
Minor	27
Training and Experimental	1
Total ..	71

PART 5
ANNEXURE II

PART 5.—ANNEXURE II

Proposed Radio Services in the immediate Post-War Period.

(Inter-aerodrome Teleprinter circuits for operational or meteorological services have not been included.)

	H.F. W/T short distance point to point channels.				H.F. W/T long-distance point to point channels.		H.F. W/T & R/T aircraft channels.		H.F. W/T long-distance aircraft channel.		H.F. D/F.		VHF R/T and W/T (airway frequency) aircraft channel.		V.H.F. D/F.	M.F. D/F and M/F. Beacon.		VHF R/T & W/T (local control frequency) aircraft channel.		Navigational Radar Beacon.	Radar Localiser.	Glide Path.	Remarks.
	Freq. A		Freq. B																				
Cols ..	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	19)	(20)	(21)	(22)	(23)
International Airports ..	T	R	T	R	T	R	T	R	T	R	T	R	T	R	R	T	R	T	R	T	T	T	
1. Bombay	..	..	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	M.F. D/F and M.F. Beacons are included only where they exist already.
2. Calcutta	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
3. Delhi	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
4. Karachi	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
5. *Training School and Experimental Station*	1	1	..	..	..	..	..	1		..	..	..	1	..	1	..	..	1	1	1	1	1	
Major Aerodromes.																							
6. Ahmedabad	..	..	1	1	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
7. Allahabad	1	1	..	..	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
8. Bangalore	..	..	1	1	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
9. Cawnpore	1	1	..	..	..	..	1	1	..	..	1	1	1	1	1	..	..	..	..	..	..	..	
10. Hyderabad	..	..	1	1	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
11. Jodhpur	1	1	..	..	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
12. Lahore	1	1	..	..	..	..	1	1	..	..	1	1	1	1	1	1	1	..	..	..	..	..	
13. Madras	..	..	1	1	..	..	1		..	..	1	1	1	1	1	1	1	..	..	..	..	..	

14. Nagpur	..	..	1	1	..	..	1	1	..	..	1	1	1	1	1	..	..	..	..	..	..	..	
15. Peshawar	1	1	..	..	..	..	1	1	..	..	1	1	1	1	1	..	..	..	..	..	..	..	
16. Poona ..	..	..	1	1	..	..	1	1	..	..	1	1	1	1	1	..	..	..	..	..	..	..	
17. Vizagapatam	...	..	1	1	..	..	1	1	..	..	1	1	1	1	1	..	..	..	..	..	..	..	
Intermediate aerodromes.																							
18. Asansol	1	1	..	..	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
19. Aurangabad	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
20. Bezwada	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
21. Chittagong	1	1	..	..	..	..	1	1	..	..	1	1	..	..	..	1	1	..	..	..	..	..	
22. Cochin	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
23. Cuttack	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
24. Dacca	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
25. Dinjan	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
26. Gaya	1	1	..	..	..	..	1	1	..	..	1	1	..	..	..	1	1	..	..	..	..	..	
27. Guntakal (or Bellary)	...	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
28. Gwalior	1	1	..	..	..	..	1	1	..	..	1	1	..	..	..	1	1	..	..	..	..	..	
29. Jacobabad	1	1	..	..	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
30. Jaipur	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	
31. Jamnagar	..	..	1	1	..	..	1	1	..	..	1	1	..	..	..	..	..	..	..	..	..	..	

Cols. ..	H.F. W/T short-range point to point channels. Freq. A (1)	(2)	Freq. B (3)	(4)	H.F. W/T long-range point to point channels. (5)	(6)	H.F. W/T and R/T aircraft channel. (7)	(8)	H.F. W/T long-range aircraft channel. (9)	(10)	H.F. D/F. „ (11)	(12)	M.F. D/F and M.F. Beacon. (13)	(14)	Remarks. (15)
	T	R	T	R	T	R	T	R	T	R	T	R	T	R	
32. Jamshedpur	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
33. Jharsuguda	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
34. Jiwani	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
35. Multan	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
36. Quetta	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
37. Raipur	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
38. Sylhet	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
39. Trichinopoly	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
40.	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
41. Unallocated	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
42. stations for	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
43. local & fee-	..	..	1	1	..	..	1	1	..	..	1	1	..	..	
44. der routes	1	1	..	..	..	..	1	1	..	..	1	1	..	..	
Minor Aerodromes.															
45. Akola	..	..	..	1	..	..	1	1	..	..	..	..	..	..	
46. Amada Road	..	..	..	1	..	..	1	1	..	..	..	..	..	..	
47. Berhampore	..	..	..	1	..	..	..	1	..	..	..	..	..	..	
48. Bhuj	..	..	..	1	..	..	1	1	..	..	..	..	..	..	
49. Hyderabad Sind ..	..	1	..	1	..	..	1	1	..	..	..	..	..	..	
50. Ramnad	..	..	..	1	..	..	1	1	..	..	..	..	..	..	
51. Saugor	..	..	..	1	..	..	1	1	..	..	..	..	..	..	

Summary of Equipment.	*Net.*	*Spares. 10%*	*Total.*
(1) H.F. Multi-channel W/T transmitters—high power ..	8	1	9
(2) H.F. multi-channel W/T transmitters—low power ..	92	9	101
(3) H.F. multi-channel W/T & R/T transmitters—low power	71	7	78
(4) H.F. Straight Receivers ..	155	16	171
(5) H.F. D/F Receivers ..	44	4	48
(6) V.H.F. W/T & R/T transmitters—high power ..	16	2	18
(7) V.H.F. W/T & R/T transmitters—low power ..	5	1	6
(8) V.H.F. Straight Receivers	21	2	23
(9) V.H.F. D/F Receivers ..	17	2	19
(10) M.F. D/F & Beacon transmitters ..	16	..	16
(11) M.F. D/F Receivers ..	16	..	16
(12) Navigational Radar Beacons	5	1	6
(13) Radar Localisers ..	5	1	6
(14) Glide Path ..	5	1	6

52.	Sikar	..	..	1	..	1	..	..	1	1	..	..	..	..	..	..			
53.	Surat	..	..	..	..	1	..	..	1	1	..	..	..		..	..			
54.	Tezpur	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
55.	Udaipur	..	..	..	..	1	..	..	1	1	..	..	..	..	1	1*			
56.	Uterali	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
57.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
58.	.. .. ..	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
59.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
60.	.. .. ..	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
61.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
62.	Unallocated	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
63.	stations	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
64.	for local	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
65.	and feeder	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
66.	routes.	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
67.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
68.	.. .. ..	..	..	1	..	..	..	..	1	1	..	..		..	..	..			
69.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			
70.	.. .. ..	..	..	1	..	..	..	..	1	1	..	..	..	..	..	..			
71.	.. .. ..	..	..	..	..	1	..	..	1	1	..	..	..	..	..	..			

*To be retained so long as the seaplane route is required.

PART 5.—ANNEXURE III

Post-War Aeronautical Radio Organisation Estimated Cost.

A.—Radio Services.—Equipment.

		Nos.	*Rate*	*Rs.*
			Rs.	
1.	H.F. multi-channel W/T transmitters—high power ..	9	30,000	2,70,000
2.	H.F. multi-channel W/T transmitters—low power ..	101	15,000	15,15,000
3.	H.F. multi-channel W/T and R/T transmitters—low power ..	78	20,000	15,60,000
4.	H.F. Straight receivers	171	1,500	2,56,500
5.	H.F. D/F receivers	48	3,000	1,44,000
6.	V.H.F. W/T and R/T transmitters—high power ..	18	7,500	1,35,000
7.	V.H.F. W/T and R/T transmitters—low power	6	3,000	18,000
8.	V.H.F. Straight receivers	23	1,000	23,000
9.	V.H.F. D/F receivers	19	2,000	38,000
10.	M. F. D/F and Beacon transmitters } Existing apparatus	16	..	..
11.	M.F. D/F receivers } see text para of Part I	16	..	..
12.	Navigational Radar Beacons	6	7,500	45,000
13.	Radar Localisers	6	7,500	45,000
14.	Glide Path	6	4,500	27,000
	TOTAL			Rs. 40,76,500

B.—Teleprinter Services.

	No.	*Rate p/a.*	*Annual Cost.*
		Rs.	*Rs.*
Teleprinter Instruments rented from P. & T. Department ..	104	1,000	1,04,000
Teleprinter Channels rented from P. & T. Department ..	12,500 miles.	30/per mile.	3,75,000
TOTAL ..		Rs. 4,79,000	

SUMMARY

Capital.

1.	Cost of equipment (new equipment throughout excluding M.F. equipment)	40,76,500
2.	Cost of installation and ancillary equipment including masts, aerials Control lines etc., 1/3rd of the capital cost of equipment (excluding, buildings and power supply)	13,58,500
	Total Capital	54,35,000

Recurring (Annual)

3.	Radio Services—Maintenance and operation (excluding personnel and labour) @ 10%*	5,43,500
4.	Radio—Obsolescence fund per annum (To be written off in 8 years) @ 12½ % of Rs. 54,35,000	6,79,500
5.	Teleprinter Services	4,80,000
	Total annual cost .. .. Rs.	17,03,000

**Note.*—In the absence of precise data the figure of 10% has been adopted for maintenance and operation. This may have to be revised in the light of further experience.

PART 5.—ANNEXURE IV

Regional Division of the Aeronautical Radio Organisation

(Provisional)

	KARACHI	DELHI	CALCUTTA	BOMBAY	MADRAS	NAGPUR
International Stations	1. Karachi	1. Delhi	1. Calcutta	1. Bombay	..	..
Major Stations	2. Jodhpur	2. Allahabad 3. Cawnpore 4. Lahore 5. Peshawar	.. ..	2. Poona 3. Ahmedabad.	1. Madras 2. Bangalore 3. Vizagapatam.	1. Nagpur 2. Hyderabad (Dn.)
Intermediate Stations	3. Multan 4. Jiwani 5. Jacobabad. 6. Quetta	6 Gwalior 7. Jaipur 8. Unallocated. ..	2. Gaya 3. Cuttack 4. Chittagong. 5. Dinjan 6. Asansol 7. Jamshedpur. 8. Dacca 9. Sylhet	4. Jamnagar 5. Aurangabad. 6. Unallocated. 7. Unallocated.	4. Trichinopoly 5. Bezwada 6. Guntakal 7. Cochin	3. Jharsuguda 4. Raipur 5. Unallocated. 6. Unallocated.
Minor Stations	7. Bhuj 8. Hyderabad (Sind) 9. Uterlai 10. Udaipur 11. Unallocated 12. Unallocated	9. Sikar 10. Unallocated 11. Unallocated 12. Unallocated ..	10. Amarda Road 11. Tezpur 12. Unallocated	8. Surat 9. Unallocated 10. Unallocated 11. Unallocated ..	8. Berhampore 9. Ramnad 10. Unallocated 11. Unallocated 12. Unallocated	7. Akola 8. Saugor 9. Unallocated 10. Unallocated 11. Unallocated

Summary.

International Stations	.. 4 Nos.
Major Stations	.. 12 Nos.
Intermediate Stations (5 Unallocated) ..	.. 27 Nos.
Minor Stations (15 Unallocated) ..	.. 27 Nos.
Experimental and Training School Station—	..
Administered directly by Headquarters ..	.. 1 No.
	71 Stations.

PART 5.—ANNEXURE V

R=Region ; S=Station

Post-War Aeronautical Radio Organisation Estimate of Staff

	Experimental & Development Establishment and Workshop.	International (4) R.	International (4) S.	Major (12) R.	Major (12) S.	Intermediate (27)	Minor (27)	Total	Leave reserve @12½ %	Grand Total.
1. Research & Development Engineer	1	..	..	..	..	..	..	1	..	1
2. Project Engineer	1	..	..	..	..	..	..	1	..	1
3. Assistant Project Engineers	2	..	..	..	..	..	..	2	..	2
4. Workshop Superintendent	1	..	..	..	..	..	..	1	..	1
5. Assistant Workshop Superintendent	1	..	..	..	..	..	..	1	..	1
6. Engineers-in-charge (Gr. I)	2	..	..	..	..	..	..	2	..	2
7. Engineer-in-charge (Gr. II)	1	..	..	..	..	..	..	1	..	1
8. Calibrators & Inspectors	4	..	..	..	..	..	..	4	..	4
9. Foremen	4	..	..	..	..	..	..	4	..	4
10. Mechanics	5	..	..	..	..	..	..	5	..	5
11. Motor Drivers	4	..	..	..	..	..	..	4	..	4
12. Regional Radio Controllers	..	4	..	2	..	..	..	6	..	6
13. Regional Radio Officers (Traffic)	..	4	..	2	..	..	..	6 plu 1 for H.Q.	From item (15)	7
14. Regional Radio Engineers	..	8	..	4	..	..	..	12 plus 1 for H.Q.	1	14
15. Radio Officers	..	..	4	..	12	..	..	16	3	19
16. Supervisors (Traffic)	..	..	12	..	24	27	..	63	8	71
17. Station Engineers	..	..	4	..	12	..	..	16	2	18
18. Radio Mechanics	..	8	4	4	12	27	..	55	7	62
19. W/T Operators (Grade I)	9	..	32	..	60	81	27	209	From item (20)	209
20. W/T Operators (Grade II)	..	..	116	..	228	243	81	668	109	777
21. Teleprinter Operators	..	52 Channels. 104 Teleprinters.					..	416	52	468
22. Mistris	4	8	4	4	12	27	27	86	11	97
23. Cleaners	4	..	4	..	12	27	..	47	..	47
24. Head Clerks	1	4	..	2	..	..	..	7	..	7
25. Accountants	1	4	..	2	..	..	..	7	..	7
26. Storekeepers	..	4	..	2	..	..	..	6	..	6
27. Store clerks	..	8	..	4	..	..	..	12	2	14
28. Store checkers	..	4	..	2	..	..	..	6	..	6
29. Stenographers	2	4	..	2	..	..	..	8	1	9
30. Clerks	12	24	16	12	36	54	27	181	23	204
31. Traffic Clerks	..	..	24	..	48	81	..	153	19	172
32. Draftsmen	Included in H.Q. staff.	4	..	2	..	..	..	6	1	7
33. Daftries	..	4	..	2	..	..	..	6	..	6
34. Peons	12	16	12	8	36	54	27	165	..	165
35. Traffic peons	..	..	32	..	72	108	81	293	..	293
36. Chowkidars	3	..	12	..	36	54	27	132	..	132
37. Sweepers	2	4	8	2	24	27	27	94	..	94
TOTAL STAFF INCLUDING INFERIOR SERVANTS	..	..		..		..	..	..	..	2,943

CIVIL AVIATION—POST-WAR PLANS

Aeronautical Training and Education

A progressive country demands and needs both education in Aeronautics and training in Aviation—the former being of wider application than the latter. Training must be closely related to the prospects of employment in the industry, but not necessarily entirely restricted to those desiring employment. The demand for training of the youth of India in Aviation usually takes little account of the factors which impose a limitation on the prospects of employment. It is essential to have a clear view of the aim before outlining the plan. The object of an Air Force is strength—measured by numbers of aircraft and numbers of personnel, conditioned by the essential factor of quality. The aim in Civil Aviation is economic self-sufficiency, which is largely governed by the quantum of real work performed by each unit of equipment or of personnel. The object is therefore to limit the personnel to the amount of real work to be done—real work being that which produces a return.

2. It is possible to conceive a policy of unlimited expansion of aviation for the purpose of creating employment, but the air services and other activities so created would have little prospect of establishing themselves on a sound economic basis and would be a continuous burden on the country. Air transport is the backbone and much of the substance of civil flying, and by that measure we can judge the needs of the country. The Air Transport Plan which has been framed for the development of air services after the war is based on an assessment of the communication needs of the country and the prospects of attracting the travelling public in the early post-war years. It forms the foundation for further development and carries with it the germs of that development. Other air transport services and ancillary activities will grow around it. Most of the employment created in aviation depends on this air transport nucleus—whether it be the air crews and engineering and other technical staff employed by the air transport operating organisations, or the aerodrome control staff, radio and meteorological personnel manning the air routes or the directing, inspection and examining personnel employed by Government. Training for employment in Aviation is directed to the object of providing this body of personnel and limited by its dimensions. A larger training would merely produce number of unemployable personnel the cost of whose training either to themselves or the State, would be wasted. The establishment of an aircraft manufacturing industry which is frequently advocated for its own sake and for the sake of creating employment, is governed by similar factors, namely the comparatively limited numbers of aircraft needed in a soundly conceived system of commercial aviation. Aircraft manufacture will not provide a large avenue of employment in India for many years.

3. The ladder of education in Aeronautics and training in Aviation which it is desirable to create, may be ascended by the following steps:—

(*i*) *General Education.*—Instillation of general knowldege of aviation by instruction at schools and colleges and by public lectures.

(*ii*) *Flying Clubs.*—To provide facilities for the ordinary citizen to learn fly and a first step for those with professional aims; to constitute local focal centres of interest in aviation.

(*iii*) *Gliding Clubs.*—To provide facilities for the study of aeronautical problems and to practise the art of flying at less cost than by power flying.

(*iv*) *Air Service Training School.*—To provide trade and professional training for those engaged in or to be engaged in aviation—including pilots, navigators, aircraft engineers, mechanics, radio operators and mechanics, aerodrome control officers and other control staff.

(*v*) *University education.*—Higher education in aeronautical science and engineering, for those engaged or to be engaged professionally in important executive and technical work. Degree courses.

(*vi*) *Post Graduate Study and Research.*—Advanced study and research by selected men capable of advancing the science of aeronautics—probably at a central Commonwealth Aeronautical University.

(*vii*) *Professional Societies.*—Associated with all the above, there is a need for a Society such as the Royal Aeronautical Society for the dissemination of knowledge, the encouragement of study and the maintenance of a standard of professional attainments in all branches of aeronautics and aviation.

4. *General Education.*—(*i*) Education and training may be restricted to the bare bones of what is needed to produce the men needed for employment in aviation, but, approaching the problem with a broader view and with the object of spreading general knowledge of the facts of aviation and enabling the new generation to develop an informed opinion, it is desirable to start in the secondary schools and colleges. This can be done by incorporating elementary instruction in aeronautics in general science courses, particularly applied science courses. It should be supplemented by lectures with films and lantern slides, given at selected colleges in the larger cities and those which show an interest in developing the subject. Government can assist by maintaining a library of films, lantern slides, standard lectures and literature and arranging for officers of the Civil Aviation Department to lecture at places convenient to their place of duty and advising colleges on instruction to be given by their own staff and other visiting lecturers. The same assistance and advice can be extended to suitable bodies arranging public lectures. Where sufficient interest and enthusiasm exists, this should be supplemented by the development at colleges and schools of model aeroplane clubs, co-ordinated by some such body as the Model Aeroplane Society of Great Britain. General instruction should be supplemented by organised instructional visits to aerodromes by boys from local schools, to give them a practical knowledge of what aeroplanes are and do. In some schools and colleges, there will be Air Scout organisations fostered by the air Force, in which more serious instruction will be given, which will enable boys to determine whether they want to follow a career in Civil Aviation or the Air Force.

(*ii*) The Education authorities should be responsible for the organisation and general direction of aviation education as a part of the educational system of the country; technical advice and direction will be given by the Civil Aviation Department. Funds will be required for the preparation and purchase of films, slides and literature and for the expenses of arranging lectures. As the movement grows, a few special lecturers may be employed. On the small scale on which it will be started, expenditure of Rs. 2 lakhs a year will suffice, and initially this should be met from the Fund derived from the additional tax on petrol used in aviation, which is devoted to research, scholarships, training and education. One cannot attempt now to indicate the ultimate limits of this activity. If it is successful, and as India develops, there will clearly be a much greater demand. The need should be reviewed by Government from time to time, and a Standing Committee representing the Education authorities, the Air Forces and Civil Aviation should be established to co-ordinate the general educational aspects of the subject with the practical Civil Aviation aspects and with the special school and college organisations of the Air Forces designed to lead boys to an Air Force career.

(*iii*) The whole of this must be regarded as general education and not as training for any specific purpose. It has, as its ulterior motive, only a quickening of perception of the youth of the country with the possible result of attracting to the aviation industry or to the Air Forces the better types of boys, who when recruited will proceed to training with a mind better attuned to what lies before him. This general education is placed first, not because it is the most important, but because it comes first in the order of things.

5. *Flying Clubs.*—(*i*) On a subject which is familiar to almost every one in India, it is unnecessary to say much—only to convey a warning against certain common misconceptions. Flying clubs are not primarily a medium for training men for employment in aviation. If the Flying clubs are to be active and healthy, the number of members must be far in excess of those who can hope to obtain employment in aviation. A flying club composed entirely of men hoping to train themselves for

aviation employment could not in fact be active and healthy. It must attract and retain in its membership other elements, and particularly the enthusiastic amateur. Moreover flying clubs, by the nature of their constitution and organisation, are not suitable for professional and trade training. Flying clubs must be widespread geographically and consequently limited in organisation and resources. Pofessional and trade training requires material resources of considerable magnitude and specialised instructional staff. Consequently they must be concentrated in a specialised establishment. Flying Clubs can carry out *ab initio* flying training of those intending to take up the profession of flying and they provide a useful sorting out organisation for this purpose. Before the war India had to rely on the flying clubs for professional pilot training to a much later stage than is desirable. They did good work in this direction as they did in providing pilots for the Air Forces and for a time in special preliminary flying training for the Air Forces. In post-war development, however, they must be replaced for this purpose by a special machine.

(*ii*) Before the war there were seven* subsidised flying clubs in British India and two in Indian States, supported by the States.† In 1940 one additional flying club was opened at Patna and subsidised by the Government of India. In the early part of the war all the clubs were used to give elementary flying training to candidates for the Air Force. When Air Force flying schools were established some of the clubs were employed on miscellaneous flying duties for the Air Force, and the financial position of these has improved. Subsidies in peacetime varied in system, but generally consisted of a fixed payment depending on the size of the club with bonus payments for training executed, subject to a maximum of Rs. 20,000 to Rs. 25,000 a year. Government expenditure on subsidies was more or less stabilised at about Rs. 1.4 lakhs a year. At the end of 1938 there were about 1,600 members who flew 12,500 hours during the year. The clubs maintained 43 aircraft. They trained 69 new pilots and 19 pilots for the B licence during the year. At the end of the year there were 359 licensed pilots on the register of whom 93 were professionally qualified. Up to the year 1939, the clubs had trained a total of some 900 pilots of whom about 100 had become commercial pilots. Of these 114 joined the Air Forces for war service. In sundry training schemes in the first two years of the war, the flying clubs gave initial training to 516 pilots for the Air Forces, of whom 364 were accepted for commissions. For this purpose 36 pilot instructors were trained by the clubs. These figures serve to give an idea of the possition relating to private flying and training before the war, and during the early war years.

(*iii*) It would be idle to predict or plan for a very great multiplication of these activities, without a great increase of Government subsidy to reduce the cost of flying to the individual. Flying is and will remain expensive and India is relatively a poor country. No Government whether Central or Provincial, can provide free flying for all. In spite of excellent examples in some centres, it is still true that the driving force of local co-operative action, producing spontaneous and independent development, is less highly developed in India than in many countries. So long as this remains so there is a foreseeable limit to development of the flying club movement. Remembering the place of the flying club in the educational ladder, however, and having regard to the widespread acquaintance with flying which the war has brought about, it is fairly clear that there will be an increase in flying club activities and a demand for their extension to new areas. The Government of India should, as in the past, assist this development. We should however aim at devolution of responsibility to Provincial Governments and local private enterprise. The Flying Club should be regarded as a local asset, to be developed by the community which it serves. Leading citizens with means should help to spread the knowledge of flying and simultaneously provide the flying club with the basis of active work on which alone it can subsist, by giving scholarships for free or cheap flying to young men from the colleges, who have not the means to pay. Provincial Governments who have for some years been represented on the committees of flying clubs and who in some cases have taken great interest and given great help, might take a still more active part and develop this sense of local responsibility. Financial supervision of the clubs should become a

*Karachi, Delhi, Bombay, Calcutta, Madras, Cawnpore and Lahore.
†Jodhpur and Hyderabad.

Provincial responsibility, while the Central Government should continue to give grants (through the Provincial Governments), to give technical assistance such as the use of aerodromes and technical equipment and remain responsible for technical supervision.

(*iv*) The problem is first examined as a continuation of the pre-war system, with such expansion as can be induced thereby, and in the following paragraph it is examined in the light of a large increase of Government subsidy with corresponding reduction in the cost of flying. Aircraft of training types suitable for flying club operation will be available for disposal from the Air Forces after the war. Approximately 65 training aircraft purchased with Civil Aviation Funds as well as 19 aircraft the property of the clubs, have been transferred to the Air Forces and an equivalent number in more or less serviceable condition can be counted on from that source. While the price of aircraft in the first five years after the war will thereby be much reduced, other costs in particular petrol and labour, will be higher and the amount of subsidy required to maintain a flying club in active existence will not differ much from the pre-war cost. The system of subsidy payment should remain substantially as it was, namely a fixed subsidy depending on the number and types of aircraft maintained and a system of bonuses for training effected. The system should be flexible to provide for varying conditions, but the total amount will be about Rs. 25,000 a year. In the case of new clubs a capital grant of about Rs. 75,000 will be required. Some capital assistance may be needed by those clubs whose activities have been suspended during the war. One may envisage within 5 years a total of about 20 flying clubs in active operation in India, involving annual grants amounting to Rs. 5 lakhs and possibly Rs. 7.5 lakhs in initial capital grants. The majority of the additional clubs however will probably be in Indian States and the cost of these will not fall on the Government of India. The Government of India expenditure will probably amount to about Rs. 2.5 lakhs a year with Rs. 5 lakhs for capital grants to clubs during that period. Each club should aim at a membership of not less than 300 with at least 100 active flying members. They would collectively employ about 80 aircraft, 40 or 50 pilot instructors and 200 to 300 engineers and mechanics. They should each aim at about 2,000 flying hours a year. On such a basis the flying club movement will be prosperous, and provided the activity has its roots in local initiative, it will then be possible to curtail the Central Government's subsidy.

(*v*) It has been strongly represented that from the point of view of defence, flying clubs should be established in a large number of centres and the number of pilots trained greatly increased, so inducing more interest in flying and producing more potential pilots for the Air Force. Having regard to the limited number of centres in India with a population which could produce a sufficient number of people of the right type to train, we may assume on this basis of forced development a total of say 50 flying clubs, carrying out an average of 1,200 hours flying a year of which half would be employed in the training of 20 new pilots a year and half in flying practice and training of qualified pilots. This would produce 1,000 pilots a year. Capital grants of aircraft, engines and hangars would amount to Rs. 75,000 for each club or a total of Rs. 37,50,000. To spread the practice of flying to the extent envisaged, it is assumed that the cost of flying to the members would have to be limited to Rs. 15 an hour. The cost of club flying has increased and it is estimated that after the war it may average Rs. 50 an hour. The annual cost of the flying club operations will therefore be Rs. 30 lakhs or Rs. 60,000 for each club. Revenue to the clubs from flying charges would amount to Rs. 9 lakhs, and Government subsidies to Rs. 21 lakhs.

Capital Grants	.. ..	Rs. 37.5 lakhs.
Annual Subsidies	.. ..	Rs. 21.0 lakhs.

If the cost of training flying were reduced to Rs. 10 an hour, one might expect 1,500 new pilots a year with an average total flying in each club of 1,500 hours, involving an annual subsidy of Rs. 30 lakhs.

6. *Gliding.*—(*i*) Indian has one body concerned with gliding which has maintained a precarious and mainly in-operative existence for about 10 years. The

Indian Gliding Association of Bombay was started as an all-India body, but it is in effect a local organisation. Financial conditions before the war prevented any assistance being given by the Central Government for the development of gliding, though sundry proposals were examined. In 1940, stimulated by the war, a grant was made to the Indian Gliding Association for capital and recurring expenditure as an experiment initial training of pilots. Difficulty in getting suitable aircraft and materials during the war caused the attempt to be abandoned, and the Association's activities have been suspended for the duration of the war.

(*ii*) The cause of gliding in India has suffered much from uninformed and unintelligent talk and extravagent claims. Any move to establish gliding in India must be preceded by an understanding of what it means. Gliding is a sport and a medium for scientific study. It is not a medium for the training of men for employment in aviation, whether it be commercial aviation or military aviation. It stands in the same relation to commercial flying as sailing clubs do to the merchant marine. Sailing clubs are of great value as preliminary training for the youth of a country which maintains or aspires to a merchant navy, but the men to be employed must be trained in a training ship or the hard school of the sea. So with air, the men for employment must be trained on power aircraft and in specially organised schools. With this understanding can be said that there is much value in the development of gliding. Because of its relative cheapness when well managed, it provides a useful stepping stone to power flying and an excellent medium for spreading general aeronautical education, particularly suited for young men of college age. For the same reason it gives opportunities for the development of construction technique and even new design (whether in local organisations or in an aircraft factory) which do not arise so readily in the case of power aircraft operations. Government should assist this development; but even more than in the case of flying clubs, strong local initiative is necessary to establish the movement on a healthy basis. India is not topographically blessed with natural hill gliding and soaring sites, though meteorological conditions provide unsurpassed convection soaring conditions almost throughout the country and throughout the year. Gliding and soaring clubs must generally be established in flat country, and this involves power launching. Except in the case of little used aerodromes, gliding cannot be carried on at aerodromes used for general air traffic. Other level areas have to be provided and may in some cases be found in aerodromes constructed for war purposes and retained but not actively occupied after the war.

(*iii*) Government assistance may consist of capital grants for the purchase of gliding and soaring aircraft, site preparation, hangars, workshops, tools, launching gear and towing vehicles; and recurring grants towards the cost of instructors, maintenance staff and replacements. Except for the aircraft, much of the capital equipment will be available as Government disposal stock. The permanent staff can be found from among officers and men of the Indian Air Force discharged after the war. Pilots with experience of instruction on power aircraft will find little difficulty in converting themselves, by special courses, into gliding and soaring instructors. Provided the necessary local initiative is forthcoming, there might well be 10 or more gliding clubs in existence five years after the war. Capital grants amounting to Rs. 5 lakhs based on disposal prices and recurring grants amounting to Rs. 1.5 lakhs a year should suffice to establish these clubs.

(*iv*) Gliding is excluded from regulation by the Indian Aircraft Rules. Experience has shown that it is desirable that the airworthiness of the aircraft should be brought under the control of the Government Inspection organisation. The certification of glider pilots should remain a matter for the Gliding and Soaring organisations themselves, and an all-India central body should be formed by the clubs and affiliated with other national and international organisations such as the British Gliding Association and the Federation Aeronautique Internationale for this purpose.

7. *Civil Air Service Training School.*—(*i*) The most important feature of post-war training and education will be the training of men for employment in air transport and the Government Civil Aviation service. For this purpose it is proposed

to establish a Government training school or schools, which will have four main divisions—

1. Flying School for pilots and navigators.
2. Engineering School for aircraft engineers and mechanics.
3. Radio School for radio operators, radio mechanics and radio engineers.
4. Aerodrome School for Aerodrome Officers and other specialist aerodrome staff.

(*ii*) In 1935 a school was established in Delhi by private initiative—the Aeronautical Training Centre of India. This school set out to give training to all the above classes of personnel except the last. In spite of the naturally high cost of training in the absence of any form of Government assistance, about 100 trainees entered the school for various courses; and 8 pilots, 37 mechanics and 13 radio operators were passed out with some form of commercial licence. In the absence of a developed system of air transport in the country the venture proved to be ahead of its time, and in 1939 it was wound up. In 1938 a school for Aerodrome Officers was established at the Karachi Air Port under the Chief Aerodrome Officer. All men selected as Assistant Aerodrome Officers were put through a six months course in operational control and administrative duties. Apart from these specific organisations for professional training, most of the training of pilots for employment was carried out by the flying clubs with their meagre and unsuitable organisations. The two established air transport companies gave organised training to pilots whom they had engaged, and their workshops provided a medium for the training of their own mechanics to a higher standard than was possible in the flying clubs. Government gave assistance in training transport pilots (mostly employed by the air transport companies to fly heavier multi-engined aircraft than were operated by the companies, by giving short flying courses on the Government Avro X to 16 pilots). Government from time to time have arranged training in England for officers to be employed in the Civil Aviation Directorate and have given scholarships for such training to others. This embraced 10 Aerodrome Officers, 7 Aircraft Inspectors, 5 aircraft engineers and 2 pilots. Special assistance was given over a long period to a student for research work in England on aircraft design. Altogether Government special training for technical employment in civil aviation before the war was extended to about 70 personnel at a cost of approximately Rs. 3½ lakhs. Imperial Airways provided some professional training for pilots and traffic officers in their organisation—a total of six being accepted under successive schemes.

(*iii*) At the end of 1939 the numbers of personnel licensed for full commercial operation were about 90 pilots, 7 navigators, 15 aircraft radio operators and 137 ground engineers. This must be qualified by the statement that the majority of the pilots had experience only of flying single engined or light twin engined aircraft, while the mechanics too were familiar only with the smaller and simpler types of aircraft and engines. The war has provided the opportunity and the means of raising the standard of a small body of transport pilots and mechanics to something like the modern standard. This began in 1941 with the purchase of some twin engined Douglas D.C.2 14 passenger aircraft and the partial training of half a dozen crews to operate them. Before the aircraft had to be taken for Air Force duties, some of these crews helped in the Iraq evacuation. The process was resumed and carried further a year or two later when large transport aircraft began to become available and a small number of Indian crews are now flying these aircraft regularly and for the first time can be said to be carrying on modern air transport operations. In fact, the civil air transport organisation and operations in spite of restrictions, have both been considerably expanded during the war.

(*iv*) Such is the picture up to date. The meagre results and the inadequacy of training arrangements before the war were the direct result of financial stringency, the natural product of an era when the fate of most developments depended on whether they were 'escapable' or not. Primarily the financial stringency was responsible for India being without any real air transport development, and without

that there was no employment to provide a solid foundation on which to build training. Secondarily it was responsible for the failure of the one attempt to establish a professional training school in India. Except for specific training for employment in the Civil Aviation Directorate, such assistance as was given by Government to individuals was limited to that which could be provided from the special fund derived from the additional tax on petrol consumed in aviation, this small fund being earmarked for this and other specified purposes. It has to be emphasized therefore that the justification for setting up a school, thereby incidentally satisfying the incessant demand for training of men for employment in Aviation, depends first on creating that employment—that is on the adoption of the Air Transport Plan, and what follows from it.

(*v*) It is proposed to organise the Civil Air Service Training School as a Government school, and to establish an Advisory Council on which air transport operators and other prospective employers of the product of the school, as well as Air Headquarters, India, will be represented. If it is found practicable the whole school will be located in one centre, under a single Superintendent or Commandant of experience and high standing in the profession, thereby securing economy and efficiency in organisation and supervision. Such a single centre will be available with practically all necessary technical and residential buildings, in the Air Port at Drigh Road, which depends on the transfer of the Airport to Mauripur, a proposal which is under separate consideration. An alternative centre for the engineering and radio schools might be available in the Mechanics Training School at Saharanpur, designed, built and equipped by the Civil Aviation Directorate for the training of mechanics for the Indian Air Force, with a capacity of 600 trainees. This centre is unsuitable for the Flying School and Aerodrome School which, to achieve maximum efficiency, should be located in close proximity to an air transport centre and the main air routes. Moreover both these schools depend closely on the Radio School. Preferably therefore all should be located at Drigh Road.

(*vi*) The organisation of the Civil Air Service Training School proposed is set out in detail in a self-contained Appendix to this paper. The training capacity for which the School will be organised will be:—

	Length of course.	Numbers.
Pilots (including Navigators)	9 to 10 months.	40
Aircraft mechanics and engineers	2 years.	200
Radio Operators and mechanics	12 to 18 months	300
Aerodrome Officers	9 months	30
Aerodrome Control Operators, Signallers, etc.	4 to 6 months.	30

(*Note:* The numbers passed out may be as low as 60% of pilots and as high as 90% of other grades).

Assuming the use of Drigh Road aerodrome with all its buildings, the capital cost of the School will be in the neighbourhood of Rs. 28 lakhs, but in the initial stage most of the aircraft will be available as Government property, and the actual expenditure may not be more than Rs. 7 or Rs. 8 lakhs. The recurring expenditure on a full training basis will be about Rs. 21 lakhs a year, but if a constant supply of Air Force trained pilots is available, the conversion training in the Flying School will be much reduced and the recurring cost of the School will be in the neighbourhood of Rs. 15 lakhs.

(*vii*) A school organised on this basis it is expected will attract entries from other surrounding countries unable to establish such a school for themselves, *e.g.*, Burma, Ceylon, Afghanistan, Iran and other countries in the Middle East. This would go some way to meet the cost, but such support could only be expected if the school were established on a first class basis and maintained its reputation as such.

(*viii*) The extent to which pupils in the School can or should pay for their own training must be constantly reviewed. The training of pilots is beyond the reach of the purse of the private individual and must be subsidised by Government. The training of mechanics and radio operators is less costly and might in some cases be

met by the individual but radio operators, Aerodrome Officers and others selected for Government employment will have to be trained at the cost of the State. It appears that scholarships must always figure largely in the entry of pupils to the School, that fluctuations in the state of the technical labour market will vary the conditions regarding payment of fees, and that the Advisory Committee should keep these fluctuating conditions under constant review and advise Government. For the present no useful estimate of the revenue to be earned by the School can be framed.

(*ix*) In admissions to the School, preference will be given to ex-Air Force personnel, so far as they may need training. Special financial assistance to ex-Air Force trainees is also contemplated. Apart from this, pupils will, where possible, be drawn from technical institutions where they will have received the basic training in their trade, *e.g.*, motor engineering, electrical engineering and radio engineering.

9. *University Education.*—(*i*) Before the war there was evidence of a desire on the part of a number of Universities to establish degree courses in Aeronautics. These attempts were not encouraged, for the sufficient reason that India lacked the foundation of aircraft and aviation industries to justify such education. A house cannot be built from the top downwards. University education in Aeronautics before the war would merely have aggravated the evil already existing in this country in regard to academic *versus* technical education. So it will be after the war. To those who want to establish higher education in Aeronautics in India, the first care must be the establishment of an industry. Given this, then University education is an essential complementary step. The air transport plan provides for the nucleus of an air transport industry, and on such a basis a start may and should be made on University education.

(*ii*) In fact a start has been made at the Indian Institute of Science at Bangalore. Stimulated by the establishment of the Hindustan Aircraft Factory, with American aeronautical engineers able to give guidance and assistance in training and by the demand for young aeronautical engineers for service in the factory, an Aeronautics department was set up in the Institute in 1941 and diploma courses instituted. The Government of India made a grant of Rs. 1 lakh for the construction of a wind tunnel in the Institute, for the joint use of the Institute and the Factory. The product of the Institute has been employed in the factory. The department is not yet fully staffed or equipped.

(*iii*) The start made at the Indian Institute of Science should be consolidated and if necessary a grant should be made to the Institute to enable them to employ a Professor of Aeronautics and lecturers of high standing. Further capital grants for equipment may be necessary.

(*iv*) The extent to which other Universities should develop aeronautical education should be reviewed by Government from time to time. Education of adequate standard for a University cannot be organised cheaply, either in staff or equipment, nor will the demand for some time justify a large number of University courses. Controlled development and assistance in accordance with the unfolding demand and opportunities for suitable employment should be the watchword, while every effort is made to create and maintain the highest standard in the few Universities which establish chairs in Aeronautics. Practical experience in the workshops of operating companies and in aircraft factories, when they are established, should be provided during the period spent at the University, particularly during vacations. The establishment of a uniform degree standard in all universities which grant degrees in Aeronautics is essential. In this way University education will be truly complementary to the technical training school and will provide a proper foundation for the research training which is the next step in the ladder. Provisionally a token sum of Rs. 1 lakh a year should be earmarked for equipment and recurring grants for the development of University education, but as the need develops expenditure under this head will have to be multiplied.

(*v*) A University education alone is not a qualification for employment in

aviation, except in a relatively few purely scientific posts which occur in design offices, research laboratories and in the universities themselves. These posts are rare in an early stage of development. Emphasis must therefore be laid on the need for combining university education with practical work and training and there is great scope for the development by scholarships of talent revealed either in technical training or in practical work. A university education in Aeronautics for a pilot of outstanding ability is a combination which will prove of value to the pilot and his employer—but generally speaking it is the pilot who is the more difficult to find. A university education has direct application to the work of the Aeronautical engineers in responsible positions including the Aircraft Inspection staff, but it cannot eliminate the hard grind of practical engineering training. In an expanding department of Civil Aviation there will be a need for a few University trained men in the Airworthiness Department and for research and development work more closely related to their scientific and mathematical training. As the aircraft manufacturing industry slowly grows through its advancing phases, there will be need for University trained men in the drawing offices and design departments. Graduates from aeronautical courses at universities will frequently prove suitable for recruitment and training in the Civil Air Service Training School for a variety of executive posts. These are the prospective outlets for the product of the Universities, but it must never be forgotten that practical training and experience must be linked with education, if Indian aviation is to benefit.

10. *Post graduate training and Research.*—(*i*) From the technical trainees and University graduates will be thrown up from time to time men of outstanding ability. From these will be drawn the scientific leaders of the industry in the future, and for them must be provided the means of developing their ability by advanced study and research. Here we come to the limit of what the country can do for itself. India must draw from outside for some of its technical training, but her students must go outside for advanced study and research, where they can work alongside the latest devlopments and among an advanced aeronautical community. The mere physical equipment of an advanced research institute is beyond the capacity of most countries, involving as it does large scale, high speed and density tunnels, among other expensive testing apparatus. Two developments on the threshold of which we now stand—jet propulsion and helicopter flight—are sufficient to show the field of work in which India may join. Of special interest and providing a special field for Indian aeronautical engineers may be mentioned two problems—problems of tropical flight, and the development and use of Indian materials.

(*ii*) A lead has been given in this matter in Great Britain. Prosposals are under consideration for the establishment of a Commonwealth Aeronautical University and Research organisation, in which all the countries of the Commonwealth may pool their resources and jointly benefit by the high standard of institution which it will thus be possible to establish. One can visualise such a Commonwealth University having a branch of its activities in India for the study of tropical problems. However that may be, India should support this proposal and should nominate selected students from time to time for study at the University. The proposals have not gone far enough to give any figures of cost or what India's contribution might be. Nor can one indicate what number of students India might be able to nominate, but the number will be small. For the purpose of this paper, a token provision of Rs. 1 lakh a year should be made for contributions and scholarships for this purpose.

11. *Training abroad.*—The proposals in this memorandum, except in the matter of posts graduate research, aim at making India self contained in educational and training organisations. To the extent proposed it is believed that aviation development in India will require such an indigenous training organisation. No country, however, can be self-contained in aviation, nor grow up without an eye on parallel developments elsewhere. In all branches it will be necessary from time to time to send selected men to other countries for special study of some particular problem or equipment and to impart their knowledge to others on return. Commercial employers will be responsible for their own staff. Government are concerned

with their own technical staff. For example, the Chief Instructors of the Civil Air Service Training School would benefit by renewing their contact with European development every two years. Radio engineers should be deputed periodically to study the latest developments in a constantly developing science. Aerodrome Officers should periodically study the development of Flight Control technique in other countries. Officers in charge of the development of aerodromes must keep in touch with the development of aerodrome lay out and airport building plans. It is unnecessary to propose a programme, but this "foreign contact" should form a definite part of the policy of training, education and development.

12. *Aeronautical Society.*—The need for a professional institute or society to disseminate knowledge, encourage study and to maintain a high standard of professional attainment has already been referred to. It needs little elaboration. This is not a matter for Government organisation, but one requiring a little help and guidance from the Civil Aviation Department to begin with. India is not ripe for the establishment of a new society, but the establishment ultimately of an Indian Aeronautical Society must be the aim. The Royal Aeronautical Society is prepared to extend recognition to branches in India. The Society has already made arrangements for the invigilation of its examinations in India. This work should be extended, as a complement to the training programme outlined in this paper. Branches of the Society in the principal aviation centres, assisted with lantern slides and films and materials for lectures, will themselves perform some of the general educational work among the public which has been advocated, as well as the still more important function of providing a forum for the exchange and development of ideas among those employed in aviation. Above all in importance is the encouragement of qualification for the Society's degrees, which have world wide recognition, and which provide an incentive to those engaged in aviation to maintain and raise the standard of their technical work.

13. Subject to co-ordination with the scale of development of air transport and other effective activities in aviation, the ladder of technical education and training in Aeronautics which it is proposed to establish in India comprises—

(*a*) The introduction of elementary general instruction in aeronautics and aviation schools and colleges and popular education by lectures to schools, colleges and suitable societies; and the formation of Model Aeroplane Clubs to create an informed opinion and to lead the right types of youth into an aviation career. Initially an expenditure of Rs. 2 lakhs a year is proposed.

(*b*) Flying Clubs to create local centres of interest in aviation and to give preliminary flying training both for purposes of private flying and as a step towards an aviation career. On the pre-war scale of assistance, up to 20 flying clubs may be expected, involving capital grants up to Rs. 7.5 lakhs and recurring grants up to Rs. 5 lakhs a year. In order to force the pace, the cost of flying to the individual must be reduced by heavier subsidies. Fifty clubs charging Rs. 15 an hour are estimated to cost Rs. 37.5 lakhs in capital grants and Rs. 21 lakhs a year in subsidy, and might produce 1,000 new pilots a year. At a charge of Rs. 10 an hour the number of pilots trained might be increased to 1500 a year; and the subsidy would be increased to Rs. 30 lakhs.

(*c*) Gliding clubs to widen the scope for flying training as a step to power flying and as a medium for spreading general aeronautical education practically among college youths. Capital grants up to Rs. 5 lakhs and recurring grants of Rs. 1.5 lakhs a year may be required to establish 10 clubs.

(*d*) A Civil Air Service Training School established by Government to give technical training to men for employment in air transport and other aviation activities including Government service. The school will cover training of pilots, navigators, mechanics, and engineers, radio operators and mechanics and aerodrome staff. It is proposed to establish the school in one centre at Drigh Road at a capital cost, excluding aerodrome and buildings, of Rs. 28 lakhs and a recurring cost of Rs. 21 lakhs. Use of war equipment may reduce initial expenditure to Rs. 8 lakhs.

(*e*) University degree courses to be established at the Indian Institute of Science and possibly later at one or two Universities but strictly controlled as to standard and output to avoid creating a flood of theoreticians without prospect of employment. Grants up to Rs. 1 lakh a year for equipment and recurring charges will probably be required, and will no doubt have to be increased in later stages of development.

(*f*) Collaboration with other Commonwealth countries in the establishment of an Aeronautical University for post graduate training and research.

(*g*) Encouragement of the Royal Aeronautical Society as a medium for the dissemination of technical knowledge and to raise the standard of professional attainments.

(*h*) So far as the cost can be calculated, it is estimated that a very effective part of this programme could be achieved for a capital expenditure of Rs. 39 lakhs and recurring expenditure of between Rs. 25 and Rs. 30 lakhs a year.

F. TYMMS.

PART 6.—APPENDIX

CIVIL AIR SERVICE TRAINING SCHOOL

General Organisation.

To deal with the problem of supplying trained men for employment in civil aviation after the war, both in Government service and commercial and private employment, it is proposed to establish, as a Government institution, a Civil Air Service Training School, combining in one centre the interlocking training of officers and men for different branches of aviation activity. This school must be organised on such a basis that it can be developed to keep in the lead of aviation development and satisfy the persistant demand of the country for professional training of the youth of the country in aviation. On this basis it is expected that it will attract students from neighbouring countries not so well placed as India to develop a first class training institute of their own. The School is not intended to be a University. Graduate and post graduate training in Aeronautical Engineering and Science is a separate problem, but training in the School will be the practical complement of University training.

2. The School will be organised in four main sections which are each dealt with in detail in the following sections of this Appendix—

I. Flying School—Pilots and Navigators.

II. Engineering School—Aircraft Engineers and Mechanics.

III. Radio School—Radio Engineers, Radio Operators and Radio Mechanics.

IV. Aerodrome School—Aerodrome Officers and technical subordinate aerodrome staff.

3. The Chief Instructors of each section of the School will be responsible to the Commandant, who must be a man of all round experience in aviation with special experience of training, and above all a man of high status and character, able to maintain the standing of the School as a national institution, on which the standing of Indian aviation in the world will largely depend. The Commandant will be responsible for the co-ordination and development of training and for the administration and discipline of the school.

4. A school of this character needs a suitable home. Its needs in aerodrome, buildings and equipment are considerable, and difficulty would inevitably be encountered sooner or later if it were located at an aerodrome where normal air traffic is liable to grow. The development of the two activities must eventually clash. At the same time it should be located near a centre of international traffic to maintain live contact with progress and to permit the use of the air route organisation for training. The School needs a large aerodrome, with modern equipment, hangar and workshop buildings and residential buildings sufficient to house the staff and pupils. Such a base is available in the Karachi Air Port at Drigh Road, which it is estimated has all the building accommodation required in the initial stage and is capable of all the development which any foreseeable growth in aviation is likely to demand of the School. This use of the airport at Drigh Road is dependent on developments proposed elsewhere—that the Karachi Air Port be reorganised on a new aerodrome which has been constructed at Karachi during the war and which provides a more convenient location for air traffic.

5. To ensure continuous live contact between the school on the one hand and the industry and technical development on the other, thereby enabling the training policy of the School to be moulded to changing conditions, a standing Advisory Committee should be formed. This Committee will include one or more senior officers of the Directorate and of Air Headquarters, India, the Commandant of the School, two or three representatives of the air transport companies, and, when higher aeronautical education is established in the country, a representative chosen from the teaching staff of a University. The co-ordination of education, which it is important to secure from the start will be secured by this link with the Universities.

through the Advisory Committee, until aeronautical education in India is more developed, when new machinery for this purpose will no doubt be required.

6. The organisation of equipment, buildings and staff outlined under each Section of this Appendix has to be completed by administrative offices and the administrative staff of the Commandant. The Air Port administrative building provides ample office accommodation for this purpose as well as for lecture rooms. The cost average of administration, and the following staff including the Commandant and general administration expenditure is estimated at Rs. 1.25 lakhs

Staff.

Commandant—with status of Deputy Director.
Assistant Commandant.
3 Physical Training Instructors.
1 Office Superintendent.
6 Stenographers.
20 Clerks and Typists
6 Storekeepers.
60 to 70 Storemen, Peons, Chowkidars, Sweepers, Malis.

7. *Summary.*—(*i*) The capital and recurring cost of the School, excluding capital value and normal recurring cost of aerodrome and buildings (which are dealt with as part of the general Aerodrome and Air Route construction programme) are roughly estimated to be—

Capital		Rs. lakhs
Administration	..	..
Flying School	..	23.0
Mechanics School	..	2.5
Radio School	..	2.0
Aerodrome School	..	0.35
		27.85
Say	..	Rs. 28 lakhs.

NOTE.—Much of the expensive equipment of the flying School will probably be available as Government property, and the actual expenditure may be reduced to about Rs. 7 or Rs. 8 lakhs.

Recurring	Rs. lakhs,	Rs. lakhs.
Administration	..	1.26
Flying School Operation and maintenance ..	13.3	
Staff	1.7	15.0
		16.26
Engineering School	..	2.0
Radio School	..	2.4
Aerodrome School	..	0.4
		21.06
Say	Rs. 21.0 lakhs.	

(*ii*) The School cannot be self supporting for reasons given hereafter in detail. Revenue could only be estimated on certain assumptions in relation to a normal year, after training of personnel discharged from the Air Force has been completed, and when a certain number of foreign fee paying students may be expected. Pilots may then be expected to pay a nominal fee of Rs. 5,000 for a year's training and 25% might pay the full cost of say Rs. 40,000. Some mechanics might pay the full cost of training say Rs. 1,000 a year. Radio operators for commercial employment may pay the cost of training, say Rs. 1,500. Governments of other countries who nominate students for training in any section of the school will pay the full cost. While there is so much doubt regarding the factors which will determine the payment of fees, no useful purpose would be served by an estimate of the revenue to be obtained from the School. It may be that at one time the School will largely be on a free

training basis, while a change of conditions in the technical labour market will put it on a largely fee paying basis. The justification for the School must at this stage be judged on the broad general issue of the desirability of aviation training, with the knowledge that a considerable part of the cost will fall on Government and that scholarships must always feature largely in the operation of the School. The Standing Advisory Committee has been recommended with one of its principal objects to advise on this aspect of the problem which cannot be clearly foreseen at present.

SECTION I—FLYING TRAINING SCHOOL

8. *Objects and General Principles.*—(*i*) The object of this branch of the Air Service Training School is to give professional training to deserving men and to produce the trained men required as air transport pilots, navigators and flying instructors. Employment in air transport arises in scheduled air services, taxi and charter flying, and flying of private aeroplanes maintained by companies and individuals for their own use. A few men with this training may be required for employment by Government but in the main the training is for private employment. The cost of training is high because it can only be given by practical flying and transport aircraft are costly to operate. It is a debated point whether the cost of training for private employment should not be met by the trainee or his prospective employer. To leave the cost of advanced training to the individual means recruitment only from the well to do—a method not likely to produce satisfactory results. To leave it to the employer means restriction of training to men already selected for employment on other grounds and a tendency to restrict the amount of training. The expensive specialised equipment and specialised instructors which it is possible to concentrate in a central school cannot be provided by each employer individually. The conclusion therefore is that the Flying Training School must be a State enterprise operated largely at State expense for the general advantage of raising the professional standard.

(*ii*) Indian Air Force pilots seeking employment as civil pilots after the war should be admitted free as part of the rehabilitation programme. This will be subject to selection and restriction of numbers. Air Force flying is not a complete training for air transport and special conversion courses are necessary. Some civil pilots, who have accumulated considerable experience, other than transport flying, by flying for war training, may be similarly treated. When these sources of recruitment are exhausted, the school will settle down to a more normal routine and in this stage, selection for vacancies will be made by examination and other tests, mainly from pilots trained in flying clubs who have a prescribed minimum of air experience. In order to achieve the object of maintaining a high standard the air transport operators must be encouraged to place their pilots under training in the school and, while they should make some contribution, the full cost of training might deter them from taking full advantage of the School. Vacancies should be reserved for this purpose. Vacancies should also be reserved on repayment terms, for nominees of neighbouring countries such as Ceylon, Burma and Afghanistan who may wish to take advantage of an institution which they could not individually afford to establish themselves. Finally, a few vacancies may be reserved for men who fail to be selected under the above heads, but who satisfy the Selection Board that they are fit to undergo instruction and are prepared to pay the cost of their own training. The principles governing repayment of the cost of training in this highly expensive school must be subject to constant review and adjustment to meet changing conditions. Liberal scholarships must probably always be a feature of the School. Beyond the general principle that the individual trainee cannot meet more than the cost of living and a nominal proportion of the cost of training, it is not possible to go at present.

(*iii*) It is proposed to organise the school with a capacity of 40 pilot trainees. The numbers will be varied according to the demand and will include from time to time men undertaking navigation training only.

(*iv*) The training policy and the estimates may be very greatly modified by the development of Air Force policy which cannot yet be foreseen. Should a "Short Service" policy be adopted in the Indian Air Force after the war, there will, after a period of years, be a constant flow of trained pilots from the Air Force seeking employment in Civil Aviation. It should be the policy of Government and the country to give these men priority in employment, and their employment may well exclude other sources of recruitment. Short service pilots from the Air Force may be expected to have accumulated about 1,000 hours flying experience, and, while they will need such of the ground training in the School their flying training will be restricted to conversion courses and special flying exercises, amounting to approximately one quarter of the flying training outlined below. If such a state of affair were established, the cost of the Flying School would be considerably reduced, both in regard to capital equipment and operating costs and in staff.

9. *Curriculum of Training.*—The training will comprise a co-ordinated course of ground and air training, comprising—

(*a*) *Ground Training.*

(*i*) Link Trainer instruction in navigation and instrument flying.

(*ii*) Aerodynamics; Theory of Structures; Aircraft Materials; Internal Combustion engines; Care and maintenance of aircraft and aero engines.

(*iii*) Air Navigation (including radio navigation and including astronomical navigation for 1st class Navigators).

(*iv*) Meteorology.

(*v*) Signalling and signalling procedure.

(*vi*) Airmanship; air route flying procedures; air route organisation; air transport practice.

(*vii*) Air law and regulations affecting aviation.

(*b*) *Flying Training.*

(*i*) Graduated flying training, including heavy multi-engined types of aircraft.

(*ii*) Instrument and radio flying.

(*iii*) Navigation flights and air route flying by day and night.

The following for Pilot Instructions only:

(*iv*) Aerobatics.

(*v*) The procedure and practice of flying instruction.

The full course will take 9 to 10 months and normally will include about 200 hours flying. A pilot who completes the course successfully will have a commercial pilot's licence (B Licence) and subject to flying experience a 2nd Class Navigators Licence. He will be qualified to act as second pilot in certain types of scheduled air transport. Subsequent experience in air transport will qualify him to command transport aircraft. If specialised in flying instruction and having accumulated the necessary flying experience, he will have a Pilot Instructor's Licence.

10. *Equipment and Buildings.*—(*a*) The essential equipment of the school includes:—

(*i*) *Aircraft.*

3 Light Trainers.

3 Single engined light cabin transport aircraft.

4 Light twin-engined cabin transport aircraft.

3 large multi-engined transport aircraft.

Note.—The multi-engined aircraft will be used as flying class rooms as well as for flying training.

(*ii*) Spare engines and aircraft and engine spares.

(*iii*) Tools and equipment.

(*iv*) 12 Link Trainers—Some of these will be installed in different centres in India for refresher training.

(*v*) Navigation instruments, books, models, signalling apparatus.

(*b*) The essential buildings include:—

(*i*) Hangars (20,000 sq. ft. approx.)

(*ii*) Workshops and stores for overhaul and repair of aircraft and engines (7,500 sq. ft. approx.)

(*iii*) Class rooms and offices.

(*iv*) Living quarters and Mess for staff and 40 pilots.

(*c*) The aerodrome at which the School is located must be fully equipped with Radio Communication and D. F. Stations with radio approach and landing systems, and with night flying organisation and equipment. The radio equipment will serve the triple purpose of training air crews, radio operators and Aerodrome Officers.

(*d*) The cost of the equipment and buildings is governed by the extent to which existing property of Government is used. The bulk of the equipment required in the initial stage will already be available in India, or may be purchased at disposal prices from H.M.G. There is considerable latitude in the types of aircraft to be used and what is available at the time will be adapted. Provision must be made for replacement of aircraft after a period of about five years. Link trainers are available in India, some having been purchased from Civil Aviation funds and transferred to the Air Force. Some of the apparatus may not be available in India, but it is available in large quantities in Great Britain. If the School is located at the Air Port at Drigh Road the building costs will be limited to minor conversion of buildings, supply of furniture and subsequent maintenance. The cost of the aerodrome, buildings, lighting and radio equipment is included in the Works and Radio Programme and not exhibited separately here. An approximate estimate of the value of equipment is given, because provision has to be made for its replacement after the initial period:—

	Capital	Recurring (Annual)		
	Normal value.	Initial reconditioning: Installation etc.	Replacement provision (Depreciation and obsolescence)	Maintenance (Materials)
	Rs.	Rs.	Rs.	Rs.
Equipment—				
Aircraft	13,00,000	1,00,000	2,60,000	1,00,000
Engines and Spares ..	3,00,000	..	60,000	..
Link Trainers	3,25,000	50,000	40,000	5,000
Apparatus	50,000	5,000	5,000	..
Tools and Equipment ..	50,000	..	5,000	5,000
Works				
Aerodromes and Buildings ..	(Works Construction Programme)	1,00,000	..	(Works Construction Programme)
Furniture	..	25,000	..	..
	20,25,000	2,80,000	3,70,000	1,10,000

The value of the equipment in use will be approximately Rs. 20 lakhs. Broadly aircraft will have to be replaced in five years and other equipment in ten years which may be regarded as Rs. 3.7 lakhs a year or as capital expenditure equal to the value o the equipment at the end of the period.

Actual initial expenditure, assuming war equipment to be used in the initial stages, should be approximately Rs. 1½ lakhs for equipment and a similar amount to be provided from the Aerodrome and Air Route Construction Programme for buildings.

Maintenance of equipment will amount to about Rs. 1 lakh a year.

Operation of aircraft and other equipment in a year of full operation of the school (40 pilots : 8,000 hours flying) will amount to about Rs. 8½ lakhs (mainly petrol and oil).

11. *Staff.*—(*i*) The administrative staff is dealt with under a common head for all departments of the School. The technical staff will consist of a Chief Instructor, six pilot instructors, and lecturers for ground instruction, together with engineering staff for the maintenance of the aircraft. The Chief Instructor, subject to the general guidance of the Commandant of the School is the key to the success of the Flying Training School. He must be a Transport Pilot of wide experience, with a sound appreciation of the relative value and importance of the various aspects of a pilot's duties, combined with the ability to organise and methodise instruction. He must be supported by a team of pilot instructors adequate to impart instruction and supervise flying amounting to 8,000 hours a year. The number is large because the value of this flying instruction depends on constant check and elimination of incipient faults, to achieve the object of precision flying, navigation and airmanship. Without adequate instructors, much of the flying time will be wasted. They must be men of wide air transport flying experience, and must include one or two experienced flying instructors to train other pilot instructors (for *ab initio* training), others who are qualified Link Trainer instructors and some who can lecture on Air Navigation, Airmanship and other allied subjects.

(*ii*) The Pilot Instructors cannot supervise all the flying and deliver all the ground instruction. Aerodynamics and engineering subjects will be taught by the staff of the Engineering and Mechanics Training School (assuming the whole Air Service Training School to be combined). A lecturer in Meteorology must be employed. He will be obtained from the staff of the Director General of Observatories. His instruction will be combined with instruction by the pilot instructors to relate theory with air practice. A lecturer in Air Navigation is required to deal with the more advanced instruction and to supplement the work of the pilot instructors who will be too fully employed to handle the whole subject. Signals instruction combined with the elements of radio will be given by the staff of the Radio School, which should be located in the same place. At least one lecturer will be required to deal with the other more general subjects. Navigation, Meteorology, Signals and Radio procedure, air law and regulations are in some degree common with the training of Aerodrome Officers, and instructional staff will be common. The whole will be supplemented by visiting lecturers from other departments of the School and outside, to inculcate and maintain the widest professional outlook in the pupils turned out from the School.

(*iii*) The cost of the staff required will be high, because none but experienced men can impart the necessary standard of instruction, and the earning capacity of experienced transport pilots is high. A tentative estimate for the undermentioned staff amounts to Rs. 1·7 lakhs annually.

Instructional staff.

1 Chief Instructor.

6 Pilot Instructors.

4 Lecturers

Engineering staff.

1 Chief Engineer.

50 Engineers and Mechanics skilled and semi-skilled.

20 Unskilled workers.

This does not include administrative staff and technical instructors borne on other departments of the School.

12. *Summary of Costs.*—The summarised costs of the Flying Training School, taking credit for what is expected to be available after the war, are estimated as follows :—

(*a*) *Capital*

	Rs. (lakhs)	Remarks.
Aerodrome and Buildings	1·25	Aerodrome and buildings assumed to be available.
Aircraft	1·0	Aircraft and spares assumed to be available.
Other Equipment	1·0	Link Trainers and part of other equipment assumed to be available.
Total Capital	3·25	

(*b*) *Recurring*

Aerodrome and Buildings		Incorporated in Works Programme.
Aircraft replacement and maintenance	4·2	
Aircraft Operation	8·5	
Equipment replacement and maintenance	0·6	
Staff	1·7	
Total Recurring	15·0	

The cost of training a pilot excluding messing and overheads of the School will amount to approximately Rs. 37,500.

13. If the School becomes mainly a medium for the conversion training of Indian Air Force "Short Service" officers, the amount of aircraft equipment will be reduced to about one half and the amount of flying to about one third of the estimate. The value of aircraft and engines in use would be Rs. 8 to Rs. 10 lakhs instead of Rs. 16 lakhs. Annual provision for replacement would be reduced by approximately Rs. 1¼ lakhs, and the cost of operation by about Rs. 5 lakhs a year. This in effect means that part of the cost of training would be borne on Air Force votes. The cost of training each pilot would then be approximately Rs. 21,000.

SECTION II.—AIRCRAFT ENGINEERS AND MECHANICS SCHOOL

14. *Objects and General Principles.*

(*i*) The main purpose of this branch of the Civil Air Service Training School is to produce a supply of aircraft mechanics with all round training for employment on the air lines and by other operators of aircraft. The training may to some extent include training in special trades, particularly those peculiar to aircraft engineering but specialised training for limited occupation is not the normal function of the school. Advanced training in aeronautical engineering for a limited number of selected men for employment in responsible positions will be a function of the school, but not academic training equivalent to a degree course—this must be given in other more appropriate institutions.

(*ii*) It is proposed to organise the school with a capacity of 200 trainees. The numbers entered must depend on the varying demand and in the initial stage will be conditioned by the supply of trained aircraft mechanics released from the Civil Repair Organisations. These men will require special training in the school before they are fit to take their place in an operating organisation since the majority will have experience only of specialised types of work in connection with service aircraft. Demobilised Air Force personnel will be accepted but there may be relatively few from this source. A third source of selection which will tend to become the normal in later years is the technical training schools and institutions established by the

Education authorities or Labour Department which impart basic training in engineering and workshop practice and produce artisans.

(*iii*) The possibility of the School accepting a limited number of trainees from other countries, such as Burma, China and Afghanistan, etc., is visualised, in which case a special course to include the full period of basic training will be required and will be of 2 years duration.

(*iv*) The cost of training mechanics is relatively much lower than that of pilots. The product of the school will be mainly for commercial employment. It may not be easy to arrange that the cost shall be borne directly by the industry, while it may be too high for the type of individual who will seek this kind of employment. Other countries will be required to meet the cost of training of their nominees and it is certain that, to achieve the object of the school Government scholarships on a fairly large scale will be necessary.

15. *Curriculum of Training.*

(*i*) The course of training, both in scope and duration, will be varied to suit the type of entrants and the results desired from time to time. It will cover—

(A) *Workshop and general engineering.*

(*a*) Revision of basic training.

(*b*) Advanced workshop practice; special tools, jigs and equipment.

(*c*) Advanced engineering practice; standards, measurements, and drawings.

(*d*) Materials; identification treatment and test.

(B) *Engines.*

(*a*) General construction and special features of aero-engines.

(*b*) Carburation and supercharging.

(*c*) Ignition systems.

(*d*) Complete overhaul and test running.

(C) *Airframes.*

(*a*) Aerodynamics.

(*b*) Modern aircraft structures.

(*c*) Practical overhaul and repair of airframes.

(D) *Miscellaneous ancillary equipment.*

(*a*) Automatic pilot installations.

(*b*) Hydraulics.

(*c*) Aircraft electrical installations.

(*d*) Instruments and their installation.

(*e*) Airscrews.

(E) *Aircraft Rules and Regulations: Inspection Procedure.*

(*ii*) The full course for the first few years (say 3) will normally occupy 14 months, 12 of which will be in the training school and a further period of 2 months practical experience on the daily servicing of aircraft at the Flying Training School. A trainee who successfully completes the course and the necessary term of practical experience should then be capable of qualifying as a licensed Aircraft Engineer for the grant of a Ground Engineer's licence.

(*iii*) By the end of three years it is expected that the recruitment of mechanics with experience will not be possible, the surplus available from the disbanded C.R.Os, etc., having been absorbed into other industries, and it will then be necessary to recruit young men from the Colleges and technical institutions. This type of

personnel will have to be trained fully from the first stage of basic training, and the courses in consequence must be of 2 years duration. This will continue in subsequent years.

16. *Buildings and Equipment.*

(*i*) The School need not necessarily be established at an aerodrome, but there is considerable advantage in locating it with the Flying Training School to give added interest to the trainees, to simplify their practical experience and to employ staff jointly.

(*ii*) The buildings required comprise—

(*a*) Workshops .. .. .. 25,000 sq. ft.

(*b*) Class-rooms and offices (with furniture) .. 3,000 sq. ft.

(*c*) Living quarters and Mess for staff and 200 mechanics.

(*iii*) The equipment required comprises—

(*a*) Workshop benches, equipment, hand tools and machine tools (limited number).

(*b*) Airframes and engines of sundry types (mainly unserviceable).

(*c*) Books, Diagrams, Models.

(*d*) Two Engine-Test Beds.

Ample equipment to cover (*a*) will be available from the Civil Aviation Mechanics Training Schools handed over to the Air Forces; (*b*) Airframes and engines of modern types must be provided in place of the old and obsolete equipment. This should be procurable from surplus Air Force Equipment; (*d*) can be provided from equipment at the Civil Repair Organisations surplus to Air Force needs at the end of the War.

(*iv*) The capital cost of establishing the School in view of the above can be limited to the minor cost of adaptation of buildings, transport and installation of equipment, etc., for which a provision of Rs. 2½ lakhs should be made. Provision of materials and the replacement and maintenance of equipment may be estimated at Rs 30,000 a year.

17. *Staff.*

(*i*) Apart from the common administrative staff for the Air Service Training School, the staff for this section of the School will consist of a Chief Instructor and experienced aircraft engineers as lecturers and workshop demonstrators. The lecturing staff must be adequate to cover the lectures on engineering subjects for pilots. The Chief Instructor must be an Aeronautical Engineer of first class practical experience.

(*ii*) The cost of the undermentioned instructional staff is roughly estimated at Rs. 1·6 lakhs annually.

1 Chief Instructor.
12 Aircraft Engineers (Lecturers and licensed engineers).
1 Fitter Supervisor.
13 Fitters, Carpenters and Mechanics (Instructors).

18. *Summary of Costs.*

By making use of property and equipment already held by the Government of India, the cost of the Mechanics Training School is estimated in round figures to be—

	Rs. (lakhs)
Capital	2·5
Recurring	2·0

Allowing for overheads of the School and cost of messing, the cost per trainee is roughly estimated to be between Rs. 10,500 and Rs. 2,000 a year. A full course of two years would cost between Rs. 3,000 and Rs. 4,000.

SECTION III. RADIO SCHOOL

19. *Objects and General Principles.*

(*i*) The purpose of this branch of the Civil Air Service Training School is to provide a steady flow of trained radio operators, radio mechanics and engineers, for the manning of (*a*) Government aeronautical radio stations, and (*b*) commercial aircraft employed mainly in the air transport services. To a greater extent than in the case of either pilots or aircraft engineers, the product of this school is required for Government employment, the whole cost of training for which falls on Government. These trainees will normally be entered after selection based on educational and other tests for training for specific employment. Entry for commercial training will be open to suitably educated men on payment of fees.

(*ii*) Aeronautical radio communication, which has always demanded the highest standard of personnel to meet the exacting standard of operation and maintenance necessary for aircraft safety, tends always to become more specialised. This is particularly so in relation to the revolutionary radio navigation devices developed (mainly in Great Britain) during the war. Both air and ground operators as well as mechanics must have thorough all-round training, and an appreciation of the whole of the problem (operational systems and engineering) to enable them to perform their own duties efficiently. The training must therefore be given in a common school. Both air and ground operators must have air experience and mechanics must have experience of the fitting and maintenance of aircraft radio installations. For economy this school should therefore be jointly located with the Flyig School. Flying for pilot training will be used to train radio operators; and air navigation and radio problems will be worked out in the same aircraft. Here again, the common school established at Drigh Road, Karachi best meets the need.

(*iii*) It is estimated that some 1,200 to 1,500 operators and mechanics will be required for the manning of the Government Aeronautical Radio Service within 5 years, and in the early stages up to 100 in air transport and other operations. Allowing for wastage, it is proposed to establish the school with a capacity of 300 pupils, the numbers of mechanics and operators to be adjusted as occasion may demand. After the initial staffing of the services (say after 5 years), although there will be constant development the demand will diminish and the capacity of the school may be reduced. The school will give refresher and finishing training in specialised operations and apparatus to wireless operators already engaged in the service or discharged from the Air Force at the end of the war. In addition, advanced training will be given to a selected small number of aeronautical engineers, who will be needed for the development of systems and apparatus and for higher technical posts generally.

20. *Curriculum of Training.*

(*a*) The course of training, adjusted as may be necessary for the type of entrant, will cover—

(*i*) Principles of radio telegraphy, including basic electricity and magnetism.

(*ii*) Design, operation and maintenance of radio and land line apparatus, power plant, etc.

(*iii*) Morse signalling: codes and procedure used in aeronautical radio communications.

(*iv*) Radio navigation and landing systems—apparatus and operation.

(*v*) Air exercises—communication and navigation.

The basic training for operators and mechanics is common, and the advanced training of each will be appropriately specialised.

(*b*) The duration of the course is estimated to be from 12 to 18 months. Successful trainees will be qualified on examination, and after acquiring the necessary air experience, for an air radio operator's licence. Those trained for Government service will be appointed on probation in radio stations of the Aeronautical Radio Service.

21. *Buildings and Equipment.*

(*i*) The buildings required will comprise class-rooms, workshops and the buildings required to house the separate radio communications and navigation station allocated to the school for the air training of pilots, navigators and radio operators. This special radio station will be provided for in the Radio programme covering the equipment of the air routes. In addition, quarters will be needed for 300 trainees and for the staff.

(*ii*) On the basis of common use of the Flying School aircraft, the special equipment required for the school will be reduced to simple proportions. It should include—

(*a*) Radio apparatus and land-line equipment of different types for demonstration.

(*b*) Morse keys, buzzers, lamps and other signalling apparatus.

(*c*) Books, diagrams and models.

(*d*) Class-room furniture and workshop benches and equipment.

(*e*) Tools and testing apparatus.

(*iii*) The majority of the equipment required will be available as the property of Government, either from the Civil Aviation Mechanics Training Scheme or surplus from other Air Force Schools and the P. & T. Department Radio Service. Adequate obsolete apparatus will be available for elementary training but modern radio equipment will have to be added. A sum of Rs. 2,00,000 should be adequate to cover what is needed, even though some equipment may have to be purchased from non-Government sources. Rs. 25,000 a year should be provided for replacement and modernisation of equipment.

22. *Staff.*

The efficiency of the School will depend primarily on the Chief Instructor who must be a Radio Engineer of up-to-date experience and outlook, able to adjust the training constantly to meet the needs of the services, and the constant development of new methods and apparatus. For this purpose he will receive direction from the Communications branch of the Airways Division and will maintain contact with air transport operators and with research activities. He will be assisted by two or more well-qualified radio engineers with up-to-date knowledge of the latest types of communication and navigation apparatus; also by two or more experienced lecturers; and by a number of demonstrators. This staff will also give the necessary instruction in radio to Pilots and Navigators in the Flying School. An estimate of the average cost of the following staff required is Rs. 70,000 annually.

1 Chief Instructor.

2 Radio Engineers.

2 Lecturers.

10 Demonstrators, Mechanics and Morse Instructors.

23. *Summary of Costs.*

(*i*) Provision for allowances to the Government trainees at say Rs. 50 p.m. to 275 trainees, will amount to Rs. 1,65,000 a year, in addition to costs listed above.

(*ii*) By making use of property and equipment already held by the Government of India, the cost of the Radio School is estimated to be—

	Rs. (lakhs)
Capital	2·00
Recurring	2·4

(*iii*) Allowing for overheads and cost of messing of non-Government trainees, the cost per trainee is estimated to be roughly Rs. 1,000 a year or Rs. 1,500 for the full course of 18 months.

SECTION IV. AERODROME SCHOOL

24. *Objects and General Principles.*

(*i*) The purpose of this branch of the Civil Air Service Training School is solely to train men selected for employment by Government in the Aerodrome Service, principally Aerodrome Officers but including also specialised training of some of the lower grades such as Airfield Supervisors, Signallers and Control Operators. The officers and men under training will normally have been selected for employment by examination or other means and will be on probationary employment terms. The cost of training will fall wholly on Government.

(*ii*) Aerodrome Officers are responsible for the administration of the aerodromes, but the most important part of their duties is the control of flying, which means the safety organisation. For this purpose an adequate force of watch keeping Officers is required in the aerodrome service, to ensure a responsible officer on duty throughout the day and night. These junior officers may in many cases have no administrative responsibilities until they advance in the service. The training of all officers however will embrace administration, in addition to technical duties, though it is probable that the training will in some cases be split and administrative training given later. The ideal Control Officer is one who has accumulated long years of air experience. To compensate for this lack, the training must include air training, including some training as a pilot.

(*iii*) Between 120 and 150 Aerodrome Officers will be needed to administer and control the air routes planned in India. Probably about half of these will be needed in the first two years after the war and the remainder within five years. To allow for wastage in training the School will have to deal in the early stages with classes of 30, but the size of classes may subsequently decrease. Provision will be made for a normal capacity of 30 Aerodrome Officer trainees, which will allow for accepting some foreign students. Provision will be made for 30 to 40 Airfield Supervisors, Signallers, Control Operators and other grades under training.

25. *Curriculum of Training.*

A. Aerodrome Officers.—(*i*) The course of training will comprise—

Ground Training.

(*a*) Air Law—international and domestic; air regulations; and air organisation.

(*b*) Air Communications and Flight Control systems; codes, signalling.

(*c*) Air navigation, including radio aids.

(*d*) Link Trainer; practise of navigation and control.

(*e*) Meteorology.

(*f*) Night lighting and aerodrome equipment.

(*g*) Elementary Survey.

(*h*) First-Aid and Fire Fighting.

Air Training.

(*a*) Pilot training (except for qualified pilots).

(*b*) Flight Control and Communication systems, as a member of the air crew.

(*ii*) The course of training will be similar to that established for probationary Aerodrome Officers at the Karachi Air Port before the war, but the combination of the Aerodrome School with the Flying Training School will facilitate practical training in combination with the training of pilots and radio operators.

(*iii*) While the entries consist of Air Force pilots or such men as Dufferin Cadets who have been successfully recruited in the past, the course of training will last about 9 months. Refresher courses and adjustment of training according to the experience of recruits will cause considerable variation.

B. Subordinate Technical Staff.—A course of ground training of less comprehensive standard than that for Aerodrome Officers, covering—

(*a*) Air regulations and organisation.

(*b*) Air communications and flight control.

(*c*) Signalling and codes (for Signallers).

(*d*) Night lighting and aerodrome equipment.

(*e*) First-Aid and Fire Fighting.

The course will last from 4 to 6 months according to the types of work.

26. *Buildings and Equipment.*—(*i*) The buildings required consist of classrooms and quarters for 30 officer trainees, 40 other trainees, and the instructional staff. Locating the School at Drigh Road there will be ample accommodation available and no capital provision is required except for minor modifications and adaptation of premises and for furniture—say Rs. 20,000.

(*ii*) The major equipment, namely, aircraft, Link Trainers and navigation instruments will be common with the equipment of the Flying School. Books, models, diagrams can be provided for a sum of Rs. 15,000.

27. *Staff.*

(*i*) This section of the School will eventually be put in charge of a senior Aerodrome Officer, but it will be necessary to enlist the services for a time of an experienced Control Officer from the Royal Air Force—one who has had a part in the development of the systems of control employed for the intensive flying involved in the Atlantic ferry service and mass bomber movements. Air training and general instruction such as navigation, meteorology and radio will be given by the staff of the Flying School and Radio School and this training will, to some extent, be common with the training of pilots.

(*ii*) The Chief Instructor will be assisted by two Aerodrome Officers, who will be selected in rotation from the executive staff of Aerodrome Officers, thus keeping the school in live contact with the problems of the air routes.

(*iii*) The cost of the undermentioned staff is roughly estimated at Rs. 38,000 annually:

One Chief Instructor.
Two Aerodrome Officers.
Three Demonstrators (Equipment etc.)

28. *Summary of Costs.*

Allowing for the use of Government property and equipment and staff provided for the other sections of the Civil Air Service Training School, the estimated cost is summarised below:—

	Rs.
Capital	35,000
Recurring (staff and miscellaneous) ..	40,000

Note.—The trainees will be on probationary employment terms, and pay is provided for in their own service.

CIVIL AVIATION POST-WAR PLANS

Resume of Civil Aviation Plans, Headquarters Organisation and Estimated Revenue

SECTION I.—RESUME OF CIVIL AVIATION PLANS

The projected development in Civil Aviation which the department will have to deal with is set out in the following plans which have been submitted to Government:

A. Air Transport.

(1) *Internal.*—The establishment of a system of daily air services on the main trunk routes, by commercial operation with possible Government participation; route mileage 11,000; operations totalling 17 million ton-miles of transport annually; employing 35 transport aircraft, 60 to 70 aircrews and a total personnel of 1,000 to 1,500. The plan has been accepted by Government.

Estimated Cost	Capital Rs. (crores)	Recurring (Annual) Rs. (crores)
Total—		
Capital investment of operating organisations (say)	3·00	..
Cost of operation	..	2·70
Cost to Government—		
Capital invested in operating organisations (say) ..	0·50	..
Subsidy	..	1·30
diminishing to zero within 10 years.		

Additional independent air transport development is expected to amount to at least 50% of the planned development, within 10 years. A continuation of financial assistance from Government will be necessary to produce further expansion, which it is Government's aim to achieve.

(2) *External.*—The formation of two commercial corporations, with part Government capital, for the development of air transport services from India to the west and to the east respectively. The initial establishment of services—

(*a*) from India to the United Kingdom,

(*b*) from India to the Near East,

(*c*) from India to China,

followed by further development of (*b*) and (*c*) and a service from India to East Africa.

The initial programme, when fully developed, will employ 16 to 20 large transport aircraft, 30 aircrews and a total personnel of approximately 1,600.

Estimated Cost	Capital Rs. (crores)	Recurring (Annual) Rs. (crores)
Total—		
Capital investment of operating companies	3·00	..
Cost of operation	..	2·90
Cost to Government—		
Capital invested in operating organization (say) ..	0·75	..
Subsidy	..	1·50

No substantial independent development of external air services is expected. The subsidy required to support these services will diminish but other developments recommended will also call for financial assistance.

B. Aerodrome and Air Route Construction.

A programme of construction of aerodromes with runways, hangars, workshops, traffic and control buildings, residential quarters beacons, and aerodrome lighting and the mechanical and electrical equipment of aerodromes to equip the major international and internal air routes within a period of 10 years. The plan has been accepted by Government. The programme is expected to employ steadily a staff of about 200 Civil Engineers and a labour force of many thousands. The annual recurring cost of maintenance of these works is exhibited in a Supplement to the Aerodrome and Air Route Construction Programme.

Estimated Cost

Capital	Recurring (Annual Maintenance)
Rs. 15·5 crores	.. Rs. 24·25 lakhs rising to Rs. 66·75 lakhs.

The Aviation Works Organisation for the execution of these works will be provided as a separate wing of the Central Public Works Department, the cost being included as departmental charges in the above estimate.

C. Aeronautical Radio Service.

The plan provides for the establishment of the essential radio service on the main international and internal air routes and comprises about 50 radio stations on varying scales, comprising radio communication with aircraft and point to point, for the flying control and meteorological services; teleprinter circuits for point to point and local communication; direction finding stations and radio beacons, including the initial development of radar stations. A radio experimental establishment and workshops are included in the plan. It is proposed to organise the Aeronautical Radio Service as part of the Civil Aviation Department. The senior staff required will be approximately 50 Radio Engineers and Controllers; the junior technical staff approximately 1,150 supervisors, engineers, radio operators and mechanics; miscellaneous staff—teleprinter operators, clerks, stores staff and drivers approximately 1,000; inferior staff 740; total staff 2,940.

Estimated Cost

	Capital Rs. lakhs	Recurring (Annual) Rs. lakhs
Equipment and installation of stations	60	..
Operating cost and maintenance		72

D. Aerodrome Organisation.

The establishment of Aerodrome Officers for the administration of aerodromes and flying control, with the necessary office staff and specially trained subordinates including control operators, signallers, electricians and floodlight operators, traffic hands, and drivers has been accepted by Government. The establishment is estimated to comprise—

Aerodrome Officers	138
Subordinate staff—specialised and clerical ..	1,032
Inferior	669
Total	1,839

The annual recurring cost is estimated at Rs. 17·2 lakhs.

E. Aerodrome Operation and Maintenance.

The cost of operation of aerodromes and air routes and their maintenance is exhibited in a supplement to the Aerodrome Organisation paper. Operation costs include the cost of fuel for motor transport, tractors, generating and plants, the cost of electric and water supply for air route and aerodrome lighting and general supply. Maintenance includes the maintenance of aerodromes and buildings, radio buildings and aerodrome equipment. The cost will increase as the aerodrome construction programme progresses. The average cost is estimated approximately at—

Initial .. Rs. 15 lakhs per annum.

After 10 years .. Rs. 2 lakhs per annum.

F. Aircraft Inspection.

The reorganisation of the Aircraft Inspection organisation has been proposed in a separate paper. The staff proposed numbers 24 officers, 13 other technical staff and a small office staff. The annual cost is estimated at Rs. 4·65 lakhs for staff and Rs. 22,000 for equipment.

G. Training and Education.

(1) Proposals have been submitted to Government for the training and education system required, not only for the staffing of the Government services and commercial organisations undertaking air transport and other operations but as a measure of general education, to spread knowledge of the facts of aviation. They comprise—

(*i*) General education.

(*ii*) Flying Clubs and Gliding Clubs.

(*iii*) A State-operated Civil Air Service Training School.

(*iv*) Limited university education and post-graduate training and research.

(2) The flying clubs and the Civil Air Service Training School are expected to employ from 80 to 100 aircraft, and instructional and other staff totalling approximately 400.

(3) The subsidies proposed for flying clubs and gliding, when full development has been achieved, are estimated at—

Capital	Recurring (Annual)
Rs. 12·5 lakhs	Rs. 7 lakhs

(4) General education, both elementary and advanced, will be organised by the Education departments, and provision has been made for technical assistance from the Civil Aviation Department, the cost of which is estimated at Rs. 4 lakhs a year.

(5) The cost of the Civil Air Service Training School will be governed by the cost of equipment (much of which may be available) and by varying conditions affecting the payment of fees by trainess. Subject to this, the cost, excluding buildings (which are assumed to be available) is estimated to be—

Capital	Recurring (Annual)
Rs. 28 lakhs	Rs. 21 lakhs

(6) The total estimates for Training and Education is—

Capital	Recurring (Annual)
Rs. 40 lakhs	Rs. 32 lakhs

H. Departmental Organisation Costs.

The proposed organisation of the department is set out in this paper. The estimated cost of the headquarters staff and general expenses are exhibited. A staff of 47 officers and 340 other staff is proposed. A Communications Flight for transport, general air inspection and tests is proposed. The personnel of this Flight will include 6 pilots. The capital expenditure is estimated at Rs. 8·44 lakhs. The annual cost of this general organisation is estimated at—

Staff—	Rs.
Pay of officers	9,00,000
Pay of other staff and contingent expenditure	8,63,000
Communications Flight	4,23,000
	21,86,000 say Rs. 22 lakhs

I. Revenue.

The Civil Aviation Department will derive revenue from landing and housing charges for aircraft, rent of lands and buildings, accommodation in aerodrome build-

ings for commercial purposes, commission on sales in restaurants and shops at aerodromes, rents of domestic quarters, sale of electric power and water to tenants and fees for licenses and certificates. An estimate of this revenue is given in Appendix V to the general paper (H).

Initial Revenue	Rs. 39 lakhs.
After 10 years	Rs. 94 lakhs.

In addition, revenue will accrue to Central Revenues from the excise duty on petrol, which, at the pre-war rate of duty, it is estimated, will amount to—

Initial Revenue	Rs. 66 lakhs.
After 10 years	Rs. 166 lakhs.

Summary of Government Expenditure and Revenue.

	Capital	Recurring (Annual)	
		Initial period	After 10 years
	Rs. (crores)	Rs. (lakhs)	Rs. (lakhs)
Air Transport—Internal	0.50	130	(say) 50
Air Transport—External	0.75	150	„ 50
Aerodrome & Air Route Construction (including equipment)	15.5	24	67
Aeronautical Radio Service	0.6	72	100
Aerodrome Organisation	..	17	20
Aerodrome Operation	..	15	22
Aircraft Inspection	..	5	7
Training and Education	0.4	32	32
Civil Aviation Directorate & Headquarters ..	..	17	18
Communications Flight	0.8	4	5
Total	18.55	466	371
Less revenue (Direct) ..		39	94
		427	277
Indirect Revenue—Petrol Excise duty (pre-war rate)		66	166

Summary Employment of Personnel

	Government employment.		Other employment.	
	Technical	Non-technical	Technical	Non-technical
1. Air Transport—Internal			700	800
2. Air Transport—External			600	1,000
3. Miscellaneous Transport and other operations			500	600
4. Flying Clubs and Gliding			400	300
5. Civil Aviation Direction (Headquarters Organisation)	45	340	..	..
6. Communications Flight ..	10	10	20	30
7. Aerodrome & Air Route Organisation	800	1,000	..	..
8. Aeronautical Radio Service ..	1,200	1,700	..	..
9. Aeronautical Inspection Organisation	40	40	..	..
10. Civil Air Service Training School ..	110	150	..	..
Total	2,205	3,240	2,220	2,730

SECTION II.—NEW ACTIVITIES AND DEVELOPMENTS

1. The stage has now been reached when changes in the organisation must be made, to ensure smooth working and to bring the administration into line with the advance which aviation in India is itself making. Some new activities have to be provided for, some established activities have to be provided for on an increased and a higher scale, and some have to be brought under a different form of control. The key to the organisation plan is its suitability to deal with constant growth and change not to control a static system.

2. Two major changes in control are recommended—

(1) *Aeronautical Radio Service.*—The technical advance in radio as applied to aeronautics and the increasingly specialised systems of operation, as well as the large expansion of the organisation now required, all point to the necessity of organising it is a special service under the Director of Civil Aviation. It is proposed therefore to take over from the Posts & Telegraphs Department elected radio stations and personnel and to build up the service under an officer specially qualified as a Radio Engineer with specialised knowledge of the aeronautical problem. This "Communications" Branch will form part of the Airways Division. (See below).

(2) *Aviation Work Service.*—Experience has shown that aviation works must be planned and executed under the closest direction of the officer responsible for the operation of civil aviation and its development. Planning and general direction has always been the responsibility of the Director of Civil Aviation, but failures of co-ordination of execution with direction have occurred and increasingly occur as the executive service ceases to be a special service dealing with Aviation alone. The planning and direction of new works in Aviation, is a continuously expanding and increasingly specialised activity, requiring a well qualified engineer to devote himself to study and original thought. The operational character of the aviation service (as in railways and ports) requires an executive works organisation at the disposal of the Director of Civil Aviation.

It was proposed therefore to take over from the Central Public Works Department the execution of aviation works and organise a new service for planning and execution in the Civil Aviation Department, under a Director of Works, with the powers of a Chief Engineer. This has been separately considered, and Government have tentatively decided to establish a separate branch of the Central Public Works Department under a Chief Engineer, responsible to the Chief Engineer, Central Public Works Department for administration and engineering but attached to the Civil Aviation Directorate for the execution of Aviation works with no responsibility of other works. Close liaison will be maintained between the Director of Civil Aviation, Air Headquarters, the Chief Engineer, Aviation works and the Engineer-in-Chief to secure co-ordination of Air Force and Civil Aviation works.

3. The development of internal air transport, plans for which have been accepted by Government, plans for the development of Indian international air transport and the expected big increase in other international air transport across India involve a corresponding expansion in some of the existing organisations of the department :—

(1) *Aerodrome Service.*—Additional aerodromes to be put on an operational basis with administrative and control staff, and the extension of operations to a 24-hour basis at many aerodromes, involves an expansion of the staff of aerodrome officers, control staff and other technical staff at aerodromes. Regional control officers, corresponding with the Superintending Meteorologists proposed for the Meteorological Service and with the regional officers also proposed in the Radio Service, are required for the control of operations and the supervision of aerodrome administration. Six such regions are proposed. The post of Chief Aerodrome Officer with headquarters at Karachi will be abolished and the responsibility for the aerodrome and air route organisation will be centralised in an Air Route and Aerodromes Branch of the head office, which will form part of the Airways Division. (See below).

(2) *Aircraft Inspection.*—The general expansion of aircraft operation involves natural expansion of the inspection service. Apart from this, provision will have to

be made for inspection at factories, if any of the several proposals for development of aircraft manufacture materialise. Miscellaneous manufacture of aircraft accessories, combined with major overhaul depots, will undoubtedly have to be provided for.

4. Certain new activities have to be provided for:—

(1) *Air Transport Licensing.*—Legislation recently enacted calls for the setting up of an Air Transport Licensing Board. There will be a considerable volume of work in the examination of technical and financial details of applications, in the framing of conditions of licenses, in the study of air transport technique and costs for the guidance of the Board, and in the analysis and study of records of operations carried out under licence. An effective organisation for this purpose is, in fact, one of the keys to successful development of Indian air transport. A branch of the head office under an officer, who will act as Secretary of the Board, with an inspection and checking staff, is proposed, as part of the Aircraft Division. (See below).

(2) *Aircraft Development and Research.*—India has relied to date entirely on development by other countries, though a small amount of investigation of indigenous materials has been undertaken. The Civil Aviation Directorate has to some extent been organised to deal originally with flying and engineering problems, but not with the mathematical and scientific problems on which research and development depend. University education in Aeronautics has not developed for a similar reason—that India has been in the stage of using aviation but not development independently.

The beginnings of aircraft fabrication, the need for research on materials, the inception of University education in Aeronautices and the increasing design and structural problems arising in airworthiness supervision, indicate the need for advancing India's organisation more into line with that of other countries, so that these problems can be handled independently. A small but growing section headed by a scientist as part of the Aircraft Division (see below) is proposed.

(3) *Training.*—(*i*) The initial and recurring personnel needs of the department and of the aircraft operating organisations, as well as the expressed desire from all quarters to provide the means whereby the youth of the country can secure employment in professional and technical capacities in aviation, involve the establishment of a training school organised to deal with all grades of technical staff. Training in air transport and civil aviation systems is needed for the personnel discharged from the Air Force who will seek employment. Flying clubs with meagre organisation are suitable only for initial flying training, but flying clubs and gliding clubs have to be developed. The whole subject of training and licensing of personnel will be directed by a branch of the Aircraft Division.

(*ii*) It is proposed to organise a Civil Air Service Training School (to be located at the Air Port at Drigh Road if the Air Port is established at Mauripur) for the training of the following grades of personnel –

I. Transport Pilots, Pilot Instructors and Navigators.

II. Aircraft Engineers and Mechanics.

III. Radio Operators, Engineers and Mechanics.

IV. Aerodrome Control Officers and other technical aerodrome staff.

The Civil Air Service Training School will require a considerable staff of qualified instructors with a Commandant of the School and specialist heads of each of its four departments. It is proposed to establish an Advisory Committee. The general direction of the School will be the responsibility of the Training Branch at Headquarters.

SECTION III.—PROPOSED HEADQUARTERS ORGANISATION

1. The organisation of the new services, namely the Aerodrome Service, the Aeronautical Radio Service, the Aviation Works Service and the Civil Air Service

Training School has been dealt with in detail in separate papers. The organisation of the meteorological service for aeronautics is being dealt with by the Director-General of Observatories. The detailed organisation of the Aviation Works Service will now be dealt with by the Chief Engineer, Central Public Works Department. Their place in or in relation to the head office and general organisation of the department is dealt with in this memorandum. A progressive policy in aviation, which it is the expressed intention of Government to follow after the war and which would be in accordance with a long expressed demand from many quarters, needs a well-qualified staff to lead and direct development. These proposals for the organisation of the department are based on this hypothesis.

2. The technical functions of the Directorate can conveniently be grouped under three heads—Airways, Aircraft Operation and Works—each covering subjects which are closely inter-related. While it was proposed that a Works Organisation within the Directorate should be established, it has been tentatively decided that the execution of works will be the responsibility of a separate organisation attached to the Directorate. The head office will therefore be organised in two main technical Divisions, one of which will be responsible for general administration. On this basis the Director of Civil Aviation should become Director-General and he will have as heads of the two Divisions, a Deputy-Director General (Airways and Administration) and a Deputy Director-General (Aircraft). The Director-General of Civil Aviation should have direct relations with the Financial Adviser in all matters of administration, excepting major policy. He should also have direct relations with other departments of Government on the day-to-day matters which constantly arise in Civil Aviation, and should be vested with such powers as will enable him to deal with the ordinary work of the Department on behalf of Government. Matters of major policy only should be dealt with through the Posts and Air Department, so that the machinery of Government may be freed from its growing entanglement of routine detail. This object can be achieved by designating the Director-General as ex-officio Joint Secretary to Government and the two Deputy-Directors General as ex-Officio Deputy Secretaries to Government. The organisation, with the main Divisions and subdivisions, the officers and their relationship with outstation organisation are shewn in the annexed chart (Appendix I) and described below.

Director-General of Civil Aviation in India.	Policy and ultimate control of all Civil Aviation development and organisation. Responsible to Government for the administration, and for the execution of Government policy. Adviser to Government on policy affecting Civil Aviation.

(One officer from the Aerodrome or Inspection service should serve, on a rotational basis, with the Director-General as Personal Assistant.)

Airways and Administration Division.

3. The Airways Division will be responsible for the whole of the ground organisation for aircraft operation, *i.e.*, equipment, staffing, operation and maintenance. It will embrace the present Aerodrome organisation and the Radio Service and will be responsible for liaison with the Director-General of Observatories, to provide the meteorological service required by airmen. Control of the Aerodrome and Radio organisations will be exercised through regional officers—the post of Cheif Aerodrome Officer and his organisation being abolished. The Division will be responsible, in liaison with and with the assistance of the Aviation Works Organisation, for planning all new aerodromes and other development of the air routes. It will be responsible for training policy in respect of that part of the Training School dealing with personnel for the Division, namely Aerodrome and Radio staff, as well as radio operators for aircrews and radio mechanics for commercial employment. Grouped in this Division for administrative convenience will be two general branches. One will deal with international relationships, legislation and rules and information; including international conventions and agreements for the operation of international air services, the collection and dissemination of information., Notices to Airmen, aeronautical charts, reports and publications. The other branch will be the normal Administration Branch under an Administrative Officer dealing with establishments and budget.

Principal Officers	*Function*
Deputy Director-General, Airways and Administration Division.	Control and development of air route organisation and operation. Liaison with the Meteorological Department and the Aviation Works Organisation. Administration of the whole department —establishments and budget. Negotiation of international agreements. Implementation of Conventions. Legislation and rules. Organisation of exchange and dissemination of essential information.
Director, Air Routes and Aerodromes.	Organisation, equipment, staffing, administration and operation of aerodromes and air routes. Planning of air routes and aerodromes with the assistance of the Aviation Works Organisation. Control and regulation of air traffic operations. Liaison with Air H.Q. India on air route operation and development. Licensing of aerodromes and advice to Provinces and States on aerodrome development. Training policy for aerodrome personnel.
Director, Communications.	Planning, organisation, equipment, staffing, administration and operation of the Aeronautical Radio Service, land lines and other means of communication. Training policy for radio personnel. Liaision with the P. & T. Department on licensing of radio personnel and aeronautical and aircraft radio stations. Liaison with international bodies such as C.E.R.C.A. on the development of radio for aviation. Liaison with Air H.Q. India on radio organisation for joint Air Force and Civil Aviation purposes.
Director, International Relationships and Information.	Implementation of international conventions. Drafting of legislation and rules. Co-ordination of this work with other departments. Negotiation of agreements for Indian air services abroad and foreign air services to India. Collection and dissemination of information including Notices to Airmen, aeronautical charts annual reports and special publications.
Administrative Officer	General administration work of the whole department, including Budget and Establishment.

4. *Air Routes and Aerodromes Branch.*—(i) The outstation organisation of Regional Aerodrome Officers, Aerodrome Officers and the staff of aerodromes has been dealt with in the separate proposals for Aerodrome and Air Route Organisation which have been accepted by Government. The central direction of this organisation will need a number of technical officers dealing with the following sections of the work :—

(1) Operations
(2) Equipment
(3) Works planning and co-ordination
(4) Inspection of aerodromes
(5) Estates

Operations cover flying control and administration of the aerodromes, the staff for which will amount to about 1,800. Equipment covers the development of technical equipment such as lighting and signals, and the provision and storage of all aerodrome equipment, including motor transport. Works planning and co-ordination is a key function comprising the synthesis of the needs of all the operational services and their translation into works demands. It covers the planning of new routes and layout of new aerodromes, as well as the day-to-day demands for additions to and modification of buildings and other works. The section will be responsible for the Works Budget and will work in close collaboration with the Aviation Works Organisation. The inspection of aerodromes covers new sites for aerodromes, beacons, etc. for the Central Government, aerodromes in Indian States, and private aerodromes for licensing purposes. Estates work covers the acquisition of land, leasing of land at aerodromes renting of technical and domestic accommodation and collection of housing and landing fees for aircraft. The work of the Branch, particularly works planning; and co-ordination necessitates a drawing office. The extent of travelling to be done necessitates air travel, and air inspection of aerodromes is also necessary. It is proposed therefore to provide a small fleet of aircraft for departmental work for this and other purposes. This will be the responsibility of the Aircraft Division and will be dealt with later.

(*ii*) The staff of the Branch, as of the Aerodrome and Air Route Organisation itself, will expand as the organisation grows and eventually will probably require two Deputy Directors with a number of technical officers, but where so much of the development work starts from scratch, adequate staff must be provided from the outset. It appears to be desirable to appoint one Deputy Director whose principal care in the initial stages will be works planning, equipment and inspection. Three Technical Officers, two Aerodrome Inspectors and one Estates Officer are required. To a large extent this staff will be interchangeable with the Regional and Aerodrome Officers, and eventually probably completely so, but in the early stages the large development work to be done and the smallness of the nucleus staff available will make it necessary to recruit experienced staff on a special basis for some of the key posts. It will also be necessary to strengthen the staff for the initial work by temporary staff or by using Regional staff temporarily on headquarters works.

5. *Communications Branch.*—(*i*) The organisation of the Aeronautial Radio Service which will be the responsibility of this Branch has been dealt with in separate proposals. It comprises about 70 Radio stations with an ultimate staff of approximately 2,940. The central direction of this service will need a strong central staff. (See draft.) Being an almost entirely new organisation for which a technically qualified Director will be specially recruited from abroad, latitude must be left for the organisation which he recommends. Tentatively provision has been made for a projects section complete with drawing office in the Radio Experimental Establishment and Workshops which will be located in Delhi in close association with the headquarters officer. This will reduce the head office organisation to that extent. The work to be dealt with in the head office will then fall into the following divisions :—

(1) Personnel
(2) Operations
(3) Equipment.

Personnel covers recruitment, training policy and postings. Operations covers the development of systems and the supervision of the operation of the whole service, international conventions and conferences. Equipment covers procurement, storage and distribution and the construction of new radio stations.

(*ii*) In this case also the staff will have to expand as the service is built up, but a considerable staff will be needed to deal with the major initial work of development. To some extent this may be dealt with by using Regional staff at headquarters before full regionalisation becomes possible. Probably three Deputy Directors will be needed at an early stage. Very extensive new recruitment will be needed for the Radio service generally, and in key posts special recruitment will be needed in the early years.

6. *International Relationships and Information.*

(*i*) These two subjects are grouped for convenience. Both are important and both share one common characteristic—that they deal with the work of every branch of aviation activity and therefore of each Division and every branch of the office. Both need careful co-ordination, which either suffers when the work is left to the separate branches or, as experience shews, puts a load of detail work on the head of the department. It is hardly necessary to say that Aviation is almost unique in the extent of international dealings which it involves. This Branch will differ in nature from most of the other branches with large domestic administration problems. Its work will be more individual but none the less important. On the international side, particularly, it will serve the Director-General very closely. It will have much work arising out of India's membership of the Council of the International Civil Aviation Organisation and of the Air Transport Committee and possibly the Air Navigation Commission. Legislation and rule-making arising out of international conventions and technical development will be continuous. So also will be the negotiation of agreements for international air services. On the publicity side there is a big volume of essential publication and dissemination of information in the form of Notices to Airmen, publication of aeronautical charts, air pilots, reports to international bodies such as the International Civil Aviation Organisation, Annual

Reports and the collection and collation of similar information from abroad necessary for the development and administration of civil aviation in India. In a live subject of public interest such as Aviation is, there is also a constant demand for incidental publication of information.

(*ii*) The staff proposed is a Director with two Technical Officers in the first place—one dealing with international matters, legislation and rules; the other with publicity. A well organised drawing office is essential for the latter for the preparation of maps and plans for the Air Pilot and Notices to Airmen and preparation of materials for aeronautical charts.

7. *Administrative Branch.*—The administrative work has for some time been beyond the capacity of one man to supervise. The increased work of a larger department necessitates a senior Administrative Officer of higher status than the present. He should be given the pay of an Assistant Secretary to Government and will need two Assistant Administrative officers to deal with the work, divided as follows:—

(1) Establishments, office administration and equipment.

(2) Budget.

With the transfer of the Chief Aerodrome Officer's functions to the head office, the accountant employed in the Chief Aerodrome Officer's organisation for checking of aerodrome accounts and stores might be employed in the Administrative Branch. The added work of the Radio organisation and the Civil Air Service Training School will necessitate two Accountants, and later more.

Aircraft Division.

8. In the Aircraft Division it is proposed to group all activities directly connected with the operation, development and airworthiness of aircraft. It will embrace applied operations and engineering and the technical personnel of all kinds involved. It will be responsible for air transport development and the development of other commercial uses of aviation, *e. g.*, air survey and crop dusting. The head of the Division (Deputy Director-General—Aircraft) will be a member of the Air Transport Licensing Board, while the head of the Operations Branch will be Secretary of the Board. Training and licensing of personnel will embrace the development of flying clubs and gliding and the direction of the Air Service Training School. The Division will be responsible for aircraft inspection, the scope of which will be extended to factories manufacturing aircraft, or parts and accessories. Accident investigation will be the responsibility of the Division, and it should be removed from the Inspection organisation which has hitherto handled it. Another Branch will be responsible for Development and Research which embraces current problems of design and stressing which at first will constitute its major work. The head of the Division will have a wide technical field to cover and must have corresponding experience, but there is an equally wide and diverse field in the Airways Division and it is precisely for this reason that the organisation now proposed brings these varying activities to a focus at two points, so that they may receive more adequate attention than they could get if all branches reported direct to the Director-General. The branches and their officers are detailed below:—

Principal Officers	*Function*
Deputy Director-General Aircraft Division.	Control and development of aircraft operations, engineering and technical aircraft personnel. Air transport development. Member of the Air Transport Licensing Board. Training and employment of personnel. Chairman of the Advisory Committee for Civil Air Service Training School. Development of aeronautical education. Organisation of supervision of airworthiness of aircraft. Technical development of aircraft for Indian operations. Development of aircraft manufacture and Indian materials for aircraft. Supervision of accident investigation.
Director, Air Transport and Operations.	Development of air transport, air survey and other industrial and commercial uses of aircraft. Secretary of the Air Transport Licensing Board. Subsidy agreements and air mail contracts.

Director Training and Licensing.	Development of training generally. Direction of the Civil Air Service Training School. Member of the Advisory Committee. Development of flying clubs and gliding. Examination and licensing of pilots, navigators and other aircrew personnel. Development of aeronautical education.
Director, Aeronautical Inspection.	Registration of aircraft. Supervision of airworthiness of aircraft. Inspection of aircraft, engines, materials and accessories, workshops, factories, storage and distribution organisations. Supervision of engineering personnel. Examination and licensing of engineering personnel. Training policy for engineering personnel.
Inspector of Accidents.	Investigation and analysis and report on all accidents to aircraft in India and to Indian aircraft, in accordance with the Indian Aircraft Rules.
Research and Development Officer.	Scientific and mathematical work for supervision of design and construction of aircraft—modifications and repairs. Development of use of Indian materials for aircraft construction. Advice on advanced aeronautical education.

9. *Air Transport and Operations.*—(*i*) The work of the Branch has been outlined above. It has its counterpart today in a single Technical Officer (Air Services) who is however unable to do more than the day-to-day work arising out of wartime air services. Its success depends on intensive study and methodical analysis of the material, the technique and costing of air transport and of air traffic, for which data must be collected and recorded. The Branch will be responsible for the analysis of applications for air transport licenses, the preparation of cases for the Air Transport Licensing Board, the preparation of reports and findings of the Board and the issue of licenses. It will be responsible for work in connection with air transport subsidy agreements and air mail contracts. It will also be responsible for the inspection of air transport operations and checking of pilots to ensure the maintenance of the prescribed technical standards: and for the collation, study and dissemination of operational, traffic and cost statistics. For international air services it will provide the reports required by the International Civil Aviation Organisation and the Commonwealth Air Transport Council. It may be called on to provide personnel for these organisations. Its work on air survey and other miscellaneous operations will be smaller, but can be of great importance both for the advancement of aviation and the development of other industries.

(*ii*) Since he will employ transport pilots as inspectors, the Director of Air Transport can conveniently take charge of the Communications Flights, which will be needed for the work of the department generally. This unit will be available to Government for special flights and touring of officials of other departments. Its size will be regulated by the demand. A fleet of two or three small cabin aircraft, with 4 to 6 passenger seats, and one or two 2-seat aeroplanes for tours of individual officers is proposed. They will be maintained by one of the operating companies in Delhi, but normally flown by pilots on the staff of the department, who will be needed for a number of purposes.

(*iii*) The special staff required to assist the Director will be a Deputy Director with a number of Air Transport Inspectors—two at first. It is proposed that these Inspectors, who should preferably be pilots, should constitute both the head office and the travelling staff. It may be necessary to separate the duties later but at first there will be advantages in giving the personnel a wider field. A commercial accountant will be necessary for the examination of proposals and the analysis of cost statistics. The accountant should be an experienced statistician to deal with the considerable volume of statistical work and its proper development. Two or more pilots will be employed for the Communications Flight.

10. *Training.*—(*i*) The programme of training and education, the development of flying clubs and gliding and the establishment of a Civil Air Service Training School has been dealt with in separate proposals. The Branch of the headquarters office to deal with this work and the licensing of aircrew personnel has its present counterpart in a single Technical Officer, who up to now has dealt with flying clubs and training. The great importance of training to ensure that Indian personnel are

enabled to take their place in aviation and to provide the steadily increasing numbers of personnel required for air transport and other development, as well as the higher standard to which training must be carried, all necessitate a strengthening of the organisation. To direct this work it will be desirable to obtain the services of an officer who has experience and made a success of training on a large scale in the Air Force—one to whom both the principles of training and the organisation of training can safely be entrusted.

(*ii*) The Director of Training will need the assistance of a Deputy Director and two or three Technical Officers and Examiners. Hitherto we have relied on Flying Club Instructors to examine their own trainee pilots. There is little to be said for it, but economy. To preserve proper standards it will be necessary to build up a Board of Examiners. Candidates for commercial pilots' licences should be examined by official examiners, who must themselves be skilled-pilots and who will also carry out part of the necessary technical examinations. These examinations will arise principally but not solely in the Civil Air Service Training School. For Navigation examinations we have relied on the Air Ministry. A Navigation Examiner must be employed. For examinations in other subjects in the Civil Air Service Training School, personnel from the Aerodromes, Communications and Inspection Branches will be employed. Meteorological examiners will be obtained by arrangement with the Director-General of Observatories. The expansion of training and employment will necessitate development of the organisation for medical examination of personnel a matter of considerable importance. Up to now private practitioners have been employed under the general supervision of the Principal Medical Officer, Royal Air Force. Coupled with other developments in aeronautical medical science it may become necessary to employ a Medical Officer for Civil Aviation, but no action is proposed at this stage.

It is proposed to constitute a reviewing body comprising the Deputy Director-General, Aircraft Division, the Director of Training and Licensing and the Deputy Director to deal with any appeal against the suspension or cancellation of licences under the Indian Aircraft Rules.

11. *Aeronautical Inspection.*—(*i*) This organisation, which will be unchanged in nature from the existing organisation, carries the important responsibility of ensuring the airworthiness of aircraft, which entails the supervision of material from its origin to its incorporation in the aircraft, and their daily maintenance, and the licensing and supervision of the personnel and organisations engaged in the work. The Aeronautical Inspection Branch is responsible for the registration of aircraft, the issue of certificates of airworthiness and the licensing of engineering personnel. It will be responsible for training policy for engineering personnel. It is proposed to relieve it of the responsibility for the investigation of accidents, but inspection personnel will still be required to assist in this work. The Aeronautical Inspection organisation exercises its function through the medium of an inspection staff organised in regions; this is dealt with in a separate paper. Even in the pre-war period great difficulty was experienced in securing a suitable man to carry these responsibilities and a high salary had to be paid to a man with the qualifications, experience and ability required to fill the post of Chief Inspector. It is proposed that the head of the organisation should in future be Director of Aeronautical Inspection.

(*ii*) For many years it has been necessary to employ one or two of the inspection staff at head office to assist the Chief Inspector. The Director of Aeronautical Inspection must tour extensively. A Deputy Director is therefore required. Other head office staff will be provided by the posting of inspectors in rotation from the regional staff. In the early stages one senior and one junior Aircraft Inspector will be needed at head office, and it will be necessary to employ one or two Inspectors on a similar rotational basis as examiners of personnel.

12. *Accident Investigation.*—The creation of a separate branch and the appointment of a special officer responsible to the Deputy Director-General, Aircraft Division for this work is the first step towards the normal organisation of an independent Inspection organisation for the investigation of accidents. It is fairly certain that India has not yet advanced sufficiently to establish an organisation of

sufficient standing and experience for this work outside and divorced from the guidance of the senior officers of the Civil Aviation Department. Nor would there be sufficient work to occupy the organisation. It is contemplated that the post of Chief Inspector of Accidents should be on the same grade as Aeronautical Inspector or Deputy Director. It may be filled by an Aeronautical Inspector, or possibly by a senior pilot of suitable qualifications drawn from the staff of the department, at first on a rotational or tenure basis, a permanent appointment only being made later when developments show it to be desirable. An Aircraft Inspector will be posted from the staff of the Inspection organisation as Inspector of Accidents. Provision has been made for the extra post. The Chief Inspector of Accidents will have the assistance of the Inspection staff, Aerodrome staff, and pilot staff of the Air Transport Branch for preliminary local investigation for complete investigation, of minor accidents, and for more extensive work if and when the incidents of accidents makes it impossible for the normal staff to deal with them as they arise. He will be responsible for co-ordination, analysis and report to the Deputy Director-General. It is proposed also to constitute a reviewing body composed of the Deputy Director-General, Aircraft, Director of Aeronautical Inspection and Director of Training who will review all reports and findings on major accidents and be responsible for resultant action. The Inspector of Accident will be responsible for preparation of all material and other work necessary in a case where Government decide to order investigation under the Indian Aircraft Rules by a Court.

13. *Research and Development.*—(*i*) This Branch will consist of a small staff of scientific officers qualified to keep pace with current developments in aeronautical science and engineering, to handle those mathematical and engineering problems which arise from day to day in the supervision of airworthiness, and at the same time to maintain a forward view to assist in guiding India's advance from the purely operational stage to the design and production stage. The free development of operations itself is hampered when India has to rely solely, as in the past, on the expert organisations of the producing countries. The first step in independent production necessitates this organisation and, properly constituted, it can do a great deal to advance the establishment of an aircraft production industry. It will have a useful field of work in the exploration and development of Indian materials for aircraft construction. The advice of scientific officers currently informed on the progress of aeronautical science and engineering is necessary to guide the development of advanced aeronautical education and India's participation in aeronautical research through such Commonwealth organisations as the College of Aeronautics to be established in England. It hardly needs saying that when India advances to a position comparable with other countries and begins to take the initiative in matters of aviation, the Research and Development organisaition of Government will grow to something very important, with its own experimental establishments, and to it will fall the task of co-ordinating and fostering all work in this field. Then, it will probably outgrow the Civil Aviation Department and become a separate organisation; but today, what is wanted is a sound nucleus.

(*ii*) As in every other new activity it is no use starting from the bottom; it will be necessary, even though the nucleus is small, to start with the advantage of the experience of other countries. The Research and Development Officer should be a man who has gained his experience of the standards and methods needed, in responsible employment in some such organisation as the Air Ministry or the Ministry of Aircraft Production. He will need at first the assistance of one Scientific Officer and two junior scientific officers (calculators). The former will be an University trained man, preferably in Aeronautics, but with practical experience of aeronautical research and for aircraft design. The latter will be young men who have attended a post-graduate course in Aeronautics, preferably at some college such as the College of Aeronautics to be established in England.

14. *Subordinate and Inferior Staff.*—(*i*) The organisation of the branches in the head office will follow the division of work set out above, and the subordinate staff required will be determined thereby and by the nature of the work of each branch. In some branches there will be a great deal of office work, while in two practically all the work will be done by officers needing little staff. The subordinate

and inferior staff is dealt with in Appendix III and the branches with their special staff are summarised below:

Subject	Office Branch	Supervision
Air Routes & Aerodromes	A.R. 1	Superintendent.
	A.R. 2	Superintendent. Drawing Office.
Communications	C. 1	Superintendent.
	C. 2	Superintendent.
International Relationships & Information	I	Superintendent. Drawing Office.
Establishments	E	Superintendent.
General	G	Superintendent.
Budget & Accounts	B	Superintendent. Accountants.
Air Transport and Operations	A.T.	Superintendent. Accountant.
Training & Licensing	A.P.	Superintendent.
Aeronautical Inspection	A.I.	Superintendent.
Accidents	R.D.	Asst.-in-Charge.
Research & Development		

(*ii*) The total staff required is estimated to be:—

Subordinate—	
Superintendents	12
Assistants, Stenographers and clerks (including one Assistant-in-charge)	208
Draughtsmen, Tracers, etc.	16
	236
Inferior—	
Record Sorters, Duftries, Peons, etc.	105
Total Subordinate and Inferior	341

(*iii*) The work of the ministerial staff of the Civil Aviation Office is not inferior to that of other Attached Offices while the need for efficient work in a department dealing with constant and rapid developments and always under a public urge for speed hardly needs stressing. It is important to attract and retain the best men capable of adjusting themselves to the tempo of the work and its developing nature. But the Civil Aviation Office is rated the lowest in the scale as measured by the varying scales of pay allotted to Superintendents. Under this condition all the best men naturally endeavour to go elsewhere. This should be rectified, by establishing the scale of pay for Superintendents on a level with the highest scale for attached offices.

(*iv*) Stenographers are needed for each officer head of a branch and a pool of stenographers for other officers. The Director-General needs two stenographers, one of whom should be granted a special allowance. The stenographers of the two Deputy Directors-General should also be granted special allowances on a smaller scale.

14. *Communications Flight.*

Appendix IV gives details of the Communications Flight which it is proposed to maintain at Delhi for the miscellaneous work of the department including special touring, air inspection of aerodromes and air routes, radio, calibration and tests, experimental test flights, tests of air crew personnel and such like operations, as well as special tours of other officers of Government. The capital cost of equipment in the initial stage after the war will be governed by aircraft disposal arrangements. It is possible that all the aircraft required will be available as the property of

Government and only a book transfer will be involved. The recurring cost will be governed by the amount of flying, of which a provisional estimate has been made, Subject to this, the cost is estimated at,—

	Capital Rs. (lakhs)	Recurring Rs. (lakhs
Aircraft and Equipment	8.44	..
Flying and maintenance costs	..	4.61
Pilot staff	..	.86
	8.44	5.47

15. *Cost of the Headquarters Organisation.*

The cost of salaries is estimated at Rs. 6.34 lakhs and the cost of Allowances and Honoraria (including Officers) and contingencies is estimated at Rs. 2.29 lakhs. The total annual recurring expenditure on the Head Office is estimated at Rs. 17.63 lakhs.

SECTION IV.—STANDING BOARDS AND COMMITTEES

It will be convenient to summarise the proposals for Standing boards and committees which will be or are expected to be set up for Civil Aviation.

(1) *All-India Air Board.*—The fact that all Post-War aviation plans are "all-India" plans, covering both British India and the Indian States, and that our aim is to unify the administration of Civil Aviation throughout India so far as practicable, in advance of constitutional changes, makes it desirable to establish an Air Board for India, which should function in a consultative capacity, to facilitate co-ordination between British India and the Indian States. This Board has been tentatively indicated in the organisation chart, Appendix I. Among other things reference would be made to the Board on international conventions applying to India as a whole and amendments to such conventions; legislation in the Indian States and its co-ordination with British Indian legislation; the progressive development of air transport in India; the participation of Indian States personnel in training schemes and employment in aviation; and the principles governing allocation of expenditure on air route and aerodrome organisation and other aviation activities.

(2) *The Air Transport Licensing Board.*—The Board of five members, partly official and mainly functional but including a representative of the Indian States will be set up under the Indian Aircraft (Licensing of Air Transport) Rules.

(3) *Investigation of Accidents Board.*—A departmental Board consisting of the Deputy Director-General—Aircraft Division, and two or three directors or other technical officers in the Aircraft Division, to review facts and findings in reports of aircraft accidents and to ensure corrective executive action.

(4) *Licence Appeal Board (Personnel).*—A departmental Board, consisting of the Deputy Director-General - Aircraft Division, the Director of Training and the Director of Air Transport to review disciplinary action in regard to licences and when necessary to consider appeals from licence-holders.

(5) *The Civil Air Service Training School Advisory Committee.*—The Committee will comprise the Deputy Director General—Aircraft Division, the Director of Training, the Commandant of the Air Service Training School, representatives of the Royal Indian Air Force and air transport and other operators, to advise on the development of technical training in the Civil Air Service Training School and its co-ordination with the needs of the industry.

SECTION V.—CIVIL AVIATION REVENUE

1. Revenue will be derived from the following sources:

(*a*) Landing and Housing Charges for aircraft.

(*b*) Rent of land, workshops, stores, offices and residential accommodation electric and water supply charges.

(*c*) Commission on sales in restaurants, hotels, bars, shops, etc., and accommodation in hotels.

(*d*) Charges in visitor's enclosures and car parks.

(*e*) Licences and Certificates.

2. *Landing and Housing Charges.*—The estimate is based on a new scale of charges which has been prepared, but not yet put into force. A new source of revenue will come into existence in the form of "Ramp Service", which will depend on the extent to which the equipment and installations are developed. These services include towing of aircraft, conditioned air supply, and sewage disposal. Some of these may be regarded as included in the landing or housing charge, and as the method of treatment has not yet been worked out, this revenue can, for the time being be regarded as included in the broad estimate of revenue given in this paragraph. Table A attached shows details of the estimate which amounts to approximately Rs. 28 lakhs a year (average) during the first five years and Rs. 65 lakhs after 10 years. The estimate is based on the following air services and developments:—

(*i*) *International air services terminating in India (non-Indian).*—Two services a day have been assumed with Tudor and York type of aircraft. For the purpose of housing it is assumed that two aircraft will be housed for the major portion of the month.

(*ii*) *International air services (Indian).*—Two companies with four services a day have been assumed. Since the bases of these companies will be in India, for housing purposes eight aircraft are shown at the base in the first five years.

(*iii*) *International services passing through India.*—Six services a day with three landings each way for E and F class of aircraft and 2 landings each way for G class of aircraft have been assumed. It is also assumed that housing will be required for only one aircraft in the first five years. The housing charge is based on the average charge for classes E, F and G.

(*iv*) *Internal services shown in the post-war plan.*—The estimate of Rs. 10.32 lakhs has been taken from the plan. It is equivalent to 0.96 annas per ton mile. It is assumed that these services will more than double themselves in 10 years, and produce double the revenue.

(*v*) *Internal services—independently developed.*—Five services with three landings each way have been assumed for the first estimate and ten services a day after 10 years. It is assumed that 10 aircraft will be housed initially and later fifteen.

(*vi*) *Charter Flights.*—The estimate is based on 20 landings per day. For housing it is assumed that five aircraft will be housed for the first five years.

(*vii*) *Flying Clubs.*—It is assumed that there will be 15 flying clubs in the first five years and 30 after ten years. The landing charges have been assumed at the rate of four landings per hour at 100 hours per month per club. It is also assumed that the flying club aircraft will not be housed in Government hangars. Although the flying clubs will not pay landing charges it is necessary to shew the revenue which is remitted by their use of aerodromes.

(*viii*) *Private Owners.*—It is assumed that there will be 50 private owners in the first five years and 150 after 10 years. The aircraft will be of mixed "A" and "B" class. For the purpose of housing it is assumed that all the aircraft will be housed in Government hangars.

3. *Rents.*—A statement is attached (Table B) showing details of the estimated revenue of Rs. 4.8 lakhs a year in the initial period and Rs. 15 lakhs a year after 10 years development. The estimates are based on the accommodation which will be available for renting when the construction programme is complete and on standard rent, and they provide for a gradual build up of revenue.

4. *Hotels, Restaurants and Shops.*—(*i*) Rent for hotels and rest houses will be obtained on an occupation basis. Based on the building programme, the pre-war rate of Rs. 2 per room per night (which will probably have to be raised) and an average occupation rate of 50 per cent., the estimated income will be Rs. 50,000 a year in the initial period and Rs. 1.5 lakhs a year after 10 years.

(*ii*) Income from hotels and restaurants (including bars) is derived in the form of a commission on sales. The rate is at present 5 per cent., but it might possibly be raised. Based on sales at existing restaurants and the progressive provision of accommodation, it is estimated that revenue of Rs. 1.5 lakhs a year will be obtained in the initial period and Rs. 3 lakhs after full development, but the revenue from this source will go on growing.

(*iii*) Bookstalls, drug stores, arts and crafts stalls, hair dressing saloons, if intelligently developed at the major aerodromes, will bring in substantial revenue in the form of a commission on sales. This may be tentatively estimated at Rs. 10,000 a year in the initial period and Rs. 50,000 a year later, but again this source of revenue will go on expanding.

(*iv*) Under this head an income of Rs. 2 lakhs rising to Rs. 5 lakhs may be expected.

5. *Visitors Enclosures and Car Parks.*—It is proposed to provide enclosures at important aerodromes where visitors will be allowed to come and watch flying operations. This practice is already followed at many aerodromes in Europe and America A fee of four annas per person and eight per car may be charged. The revenue estimated is shown below. It will not be worthwhile to provide special parks at places where the average number of visitors each day is less than 20. At some aerodromes, the right to ply for hire may be sold to particular taxi owners, but for the present no revenue under this head is estimated.

Revenue may be expected from this source at 1 international, 14 major and 7 intermediate aerodromes. On a conservative calculation, the average number of visitors and cars paying fees at these aerodromes daily will be 1,100 and 220 respectively, and the annual revenue during the first five years may be estimated at :—

From visitors :	401,500 at 0-4-0	Rs.	1,00,375
From cars.	80,300 at 0-8-0	Rs.	40,150
			1.40,525
	Say	Rs.	1,40,000

The revenue is likely to be more than doubled after 10 years—say Rs. 3 lakhs.

6. *Fees for Licences, Certificates and Examinations.*—(*i*) Revenue will accrue from the fees chargeable under the Indian Aircraft Rules for the registration and certification of aircraft, the examination and licensing of personnel and the examination of applications and issue of licences for the operation of air transport.

Aircraft.—It is proposed to extend the scale of fees for certification of airworthiness to larger aircraft, and to institute a scale of fees for the inspection of premises and issue of certificates of approval to distributors of aircraft material. A certain revenue will arise from inspection of aircraft for other Governments and assessment of damage for aircraft insurance companies. On the basis of the plans for development and estimates of numbers of aircraft likely to be operated given in other post war papers, it is estimated that the annual revenue from this source will be Rs. 30,000 in the first 5 years and Rs. 60,000 after 10 years.

Aircraft Engineers.—Revenue from examination fees and issue of licences is estimated at Rs. 10,000 in the first 5 years and Rs. 20,000 after 10 years.

Aircrew personnel (Pilots, Navigators and Radio Operators).—The revenue from examination fees and issue of licences is estimated at Rs. 10,000 in the first 5 years and Rs. 20,000 after 10 years.

Aerodromes.—For the first 5 years, it is assumed that licences will be issued or renewed for an average of 25 private aerodromes a year, producing a revenue of Rs. 750, and after 10 years 50 aerodromes, producing a revenue of Rs. 1,500 a year.

Air Transport Licensing.—It is estimated that during the first 5 years an average of 5 air transport licences a year will be issued, after the examination of 6 applications in each case, producing a revenue of Rs. 5,250 for issue and average annual fees for current licences of Rs. 1,800—say Rs. 7,000. The revenue after 10 years may be estimated at Rs. 10,000. It is possible that the fees now proposed may be raised, but for the present purpose this estimate may be accepted.

(*ii*) The total annual revenue from licence and examination fees is estimated at,

Average first 5 years	.. .. ..	Rs. 58,000
After 10 years	.. .. ..	Rs. 1,11,000

7. *Civil Air Service Training School.*—The fees to be charged in the school have been left for future examination, the principle having been propounded that, to achieve the object of Government, it will be necessary for Government to provide a large measure of free training. This will be particularly evident in the early years, when Air Force personnel will constitute a large proportion of the trainees. At a later stage, it is hoped to attract paying trainees from abroad. On broad considerations, it is considered justifiable to take credit for an average revenue of Rs. 2 lakhs a year in the initial period and Rs. 5 lakhs a year after 10 years.

8. *Petrol.*—(*i*) In the United States, a large revenue accrues to aerodrome proprietors from the sale of petrol, either in the form of a commission on each gallon of petrol sold or in the form of sale of a monopoly of supply of petrol at the aerodrome. The very high excise duty on petrol in India (As. 15 per gallon in war time, As. 10 per gallon pre-war), with the addition of sales tax in certain Provinces and States, is one of the factors in raising the price of petrol in India to five times the price in the United States. Any additional charge will be passed on to the user, and air transport is already sufficiently handicapped by these high duties and prices. This source of revenue is therefore closed for the time being, but it is relevant to show the amount of revenue which accrues to Central Revenues, from the development of aviation planned and foreshadowed in the Civil Aviation post-war papers.

(*ii*) In the Post-War Air Transport Plan (Internal Air Transport) an estimate is given of the petrol tax revenue—Rs. 44.85 lakhs at the rate of As. 15 per gallon and Rs. 29.9 lakhs at As. 10 per gallon. This system of air transport is expected to be doubled in 10 years, apart from the development of independent services with smaller aircraft. International air transport across India will be operated with large aircraft, consuming much greater quantities of petrol. In the estimate of revenue from landing and housing charges, an indication is given of the type and number of air services expected to traverse India. On this basis and allowing for training, charter and miscellaneous flying, it is broadly estimated that the annual revenue accruing from petrol tax on the basis of the pre-war duty and the present duty will be of the following order :—

	Tax at As. 10 per gallon	Tax at As. 15 per gallon
Initial 5 year period	Rs. 66 lakhs	Rs. 100 lakhs.
After 10 years	Rs. 166	Rs. 250

9. *Summary of Revenue.*—

	Average first 5 years	After 10 years
	Rs. (lakhs)	Rs. (lakhs)
Landing and Housing charges	28	65
Rents	4.8	15
Hotels, Restaurants and Shops	2	5
Visitors Parks	1.4	3
Licences and Certificates	.6	1.1
Civil Air Service Training School	2.0	5
	38.8	94.1
	Say Rs. 39 lakhs.	Say Rs. 94 lakhs

The indirect revenue accruing to Central Revenues is estimated at—

Rs. 66 lakhs to Rs. 100 lakhs

Rs. 166 lakhs to Rs. 250 lakhs.

SECTION V.—Table A

Statement showing Estimated Landing and Housing Charges for Post-War Period.

No.	Service	Landing charges. Average for first 5 years: Class of aircraft	No. of landings per day	Landing charges per year Rs.	Landing charges. After first 10 years: Class	No. of landings per day	Landing charges per year Rs.	Housing charges. Average for the first 5 years: No. of aircraft housed	Housing charges per year Rs.	Housing charges. After 10 years: No. of aircraft housed	Housing charges per year Rs.
1	External International services terminating in India (Foreign) ..	F	2	54,780	F G H	2 1 1	54,750 54,750 91,250	2	48,000	2 1 1	48,000 48,000 72,000
2	External services (Indian) ..	E F	3 1	43,800 27,375	E F G	5 2 1	73,000 54,750 54,750	6 2	86,400 48,000	10 4 2	1,44,000 96,000 96,000
3	International services passing through India	E F G	12 12 8	1,75,200 3,28,500 4,38,000	E F G H	12 24 16 8	1,75,200 6,57,000 8,76,000 7,30,000	1	28,800	2	76,800
4	Internal services shown in Post-War Plan	Landing and Housing Charges for 17,200,000 ton miles at 0.96 annas per ton mile Twice the above after ten years								Rs. 10,32,000 for the first 5 years Rs. 20,64,000	
5	Internal services not shown in Post-War Plan	C	30	1,31,400	C	60	2,62,800	10	60,000	15	90,000
6	Charter Flights	C	20	87,600	C	40	1,75,200	5	30,000	10	60,000
7	Flying Club	A	200	72,000	A	400	1,44,000	..	..	..	..
8	Private Owners	A B	10 10	3,650 18,250	A B	30 30	10,950 54,750	25 25	72,000	75 75	2,16,000
				13,80,525			34,69,150		3,73,200		9,46,800

Yearly average of Landing and Housing Charges for the first five years: 13,80,525 + 3,73,200 + 10,32,000 = 27,85,725

Yearly Landing and Housing Charges after 10 years: 34,69,150 + 9,46,800 + 20,64,000 = 64,79,950

SECTION V.—Table B

Rent from Lands, Buildings, etc.

		Average revenue per annum during period of first five years	Average revenue per annum during the period of second five years
		Rs.	Rs.
1.	Hangar rent—*i.e.*, annexes used as stores and offices ..	50,000	1,50,000
2.	Workshops, stores, garages, etc., rented to companies ..	58,000	1,75,000
3.	Traffic offices, etc., rented to companies in administrative buildings	35,000	1,45,000
4.	Rent on domestic residential accommodation	1,15,000	4,50,000
5.	Recoveries on account of electric and water charges ..	1,50,000	4,10,000
6.	Miscellaneous recoveries, *i.e.*, rent of land, grass leases, cultivation leases, miscellaneous sales	75,000	1,80,000
	Total Rs.	4,83,000	15,10,000

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on 01 February, 2020